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REPORT ON WATER POLLUTION CONTROL, SANTA ANA RIVER BASIN, CALIFORNIA DRAINAGE BASIN

Public Health Service
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REPORT
ON
WATER POLLUTION CONTROL

SANTA ANA RIVER BASIN

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FEDERAL SECURITY AGENCY
Public Health Service

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Water Pollution Series No. 18

Report on

Water Pollution Control

SANTA ANA RIVER BASIN

California Drainage Basin

Prepared by:

FEDERAL SECURITY AGENCY
Public Health Service
Division of Water Pollution Control
California and Great Basin Drainage Basins Office

in cooperation with

State and Regional Water Pollution Control Authorities

March 1, 1951

SANTA ANA RIVER BASIN OF CALIFORNIA

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of a series of reports to cover the interim period prior to the development of comprehensive water pollution control programs. The first of these reports were the Summary Reports which were prepared for the 15 major drainage basins of the country on the basis of information readily available as of July 1, 1950. The second group of reports of this series, of which this is one, are reports on several subdivisions of the country's major drainage basin areas. Since development of comprehensive water pollution control programs is to proceed as rapidly as conditions permit, only a limited number of these interim reports are to be completed, and the majority of these will be for interstate areas. These reports are based on data available as of March 1951 and will provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress makes available funds for this purpose; and serve to inform the public on the water pollution control problem and needs for the area concerned.

The data on which this report is based have been compiled through and in cooperation with State water pollution control agencies, but should not be considered a detailed engineering investigation of the Santa Ana River Basin. Through these cooperating agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance.

The 1949 California legislation which established the State and Regional water pollution control boards also defined the terms "contamination", "pollution", and "nuisance" as follows:

"'Contamination' means an impairment of the quality of the waters of the State by sewage or industrial waste to a degree which creates an actual hazard to the public health through poisoning or through the spread of disease.

'Pollution' means an impairment of the quality of the waters of the state by sewage or industrial waste to a degree which does not create an actual hazard to the public health but which does adversely and

unreasonably affect such waters for domestic, industrial, agricultural, navigational, recreational or other beneficial use.
'Nuisance' means damage to any community by odors or unsightliness resulting from unreasonable practices in the disposal of sewage or industrial wastes."

In view of the special significance attached to the use of these terms in California, the words are shown in quotation marks when the California meaning is intended.

Since California legislation requires that Regional Boards hold public hearings before they determine if a condition of "pollution" or "nuisance" is existing or threatening to exist as a result of discharge of sewage or industrial waste within its region, and since the law specifies that: "No order issued under the provisions of this article shall specify the design, type of construction or particular manner in which an operation causing or threatening to cause a condition of pollution or nuisance is to be corrected, and the person so ordered shall be permitted to correct the condition in any lawful manner", Regional authorities cannot pass upon the adequacy or inadequacy of existing treatment and disposal facilities in advance of technical studies and hearings and cannot specify type of treatment facilities that should be provided. In view of these restrictions, State officials believe that it is impossible on the basis of present information to list treatment facilities as satisfactory or unsatisfactory, and no such lists are included in the report.

These reports present information about the ways the water resources of the area are used, the pollution entering those water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, pollution prevention measures now in effect, and those which appear to be needed.

Since the reports are based on data which are presently available, they do not discuss the present and future best uses of the waters of the area as such uses are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution programs which will be developed later.

The deficiencies in data and the gaps in information indicated in these reports are as significant as the presentation of available facts and statistics. They indicate the work that still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of many of the pollution problems within the Santa Ana River Basin without awaiting the results of additional surveys and studies.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the area and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program, will help in safeguarding the water resources of the Santa Ana River Basin.

ACKNOWLEDGMENTS

This report has been prepared by the California and Great Basin Drainage Basins Office of the Public Health Service in cooperation with the California State and Regional Water Pollution Control Boards and the State Department of Public Health. Other California State agencies which furnished valuable assistance are: Department of Public Works, Division of Water Resources; Department of Natural Resources, Division of Fish and Game, and Division of Forestry; Department of Agriculture; and University of California.

Federal agencies which assisted in review of the manuscript and from whose reports much data were obtained include: Department of Agriculture, Forest Service and Soil Conservation Service; Department of the Army, Corps of Engineers; Department of Commerce, Bureau of the Census; Department of the Interior, Bureau of Reclamation, Fish and Wildlife Service, Geological Survey, and National Park Service; and Federal Power Commission.

Much of the Orange County data used in the report were taken from the 1947 Orange County Sewerage Survey, a Report upon the Collection, Treatment, and Disposal of Sewage and Industrial Wastes of Orange County, California.

The California State Chamber of Commerce, and other organizations and individuals including public officials and engineers in private practice have also contributed information.

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SUMMARY

The Santa Ana River Basin embraces an area of approximately 2,784 square miles, 1,230 in Riverside County, 1,000 in San Bernardino County, and 554 in Orange County. Elevations range from sea level to 1,700 feet at the base of the mountains and to over 11,000 feet at San Gorgonio Peak. The streams of the area have produced great natural underground water storage reservoirs by filling the bedrock basins with detritus eroded from the surrounding mountain areas. Faults, which cut through the alluvium layers, form nearly impermeable barriers to the free movement of underground water and create many well defined ground water basins.

The moist wind and fog from the ocean moderate the climate of the Basin. The average temperature at Riverside for the 66 years of record is 51.9° F. for the month of January and 75.8° F. for the month of July. Rainfall averages 11.3 in. at Riverside and 16.9 in. at San Bernardino. The average growing season for areas below 1,300 ft. is 287 days.

Stream flow is intermittent in all except the larger streams in the mountains.. Flow in the main stem of the Santa Ana River is ordinarily confined to the reach between Riverside and the intake of irrigation canals near the Orange County line.

The population of the Basin was approximately 57,000 in 1900 and 345,000 in 1940. In 1950 the population was about 576,000, an increase of 67 percent for the ten-year period as compared to an increase of 52 percent for the entire State. Approximately 70 percent of the population lives in cities and towns.

Agriculture is the primary economic activity in the Basin with the production and marketing of citrus fruits, deciduous fruits, nuts, grapes, field and truck crops, poultry, honey, dairy products, and meat leading in importance. Industrial activity is second to agriculture, but is increasing rapdily in importance. Those industries concerned with processing and handling food and food products employ the greatest number of workers, but the largest single industry in the area is the Kaiser steel mill near Fontana. Other important industries in the Basin are mining, petroleum production, the repair and manufacture of tank cars and transportation equipment, and the manufacturing of Portland cement, canning and packing machinery, chemical, clay, and metallurgical products.

All of the petroleum production of the Basin is concentrated in the coastal plain area of Orange County. The value of all petroleum products in Orange County in 1947 was $66,800.000. Other mineral products of importance in the Basin are limestone, clay, gypsum, concrete aggregate, and building stone.

The water use by irrigated agriculture is by far the greatest in the Basin. Approximately 300,000 acres of crops are irrigated out of a total of 430,000 acres of cultivated land in the Basin. Only grapes and some low value field crops are dry farmed. Of the estimated 683,000 acre-feet of water used annually in the Basin, 640,000 acre-feet are used for irrigation and only 43,000 acre-feet are used for domestic and industrial purposes.

From 20 to 25 percent of the water used in the Basin is diverted from reservoirs and surface streams, and the remainder is pumped from wells. Approximately three percent of the water used in the Basin in 1949 was imported from the Colorado River through the Metropolitan Water District of Southern California. There are nearly 200 water companies and districts supplying water in addition to the hundreds of private wells. The water systems within the area include 22 diversion dams, 130 reservoirs (mostly small), 200 miles of canals, more than 2,800 miles of pipe lines, 2,500 wells, and many water-spreading areas. There are 11 small hydroelectric plants in the Basin.

The Basin supports an important sport fishery. An estimated 90 percent of the fishing effort is salt water shore and boat fishing. Inland fishing at the larger lakes and reservoirs and stream fishing for trout in mountain streams are also popular. Commercial fishing is also of importance with principal landings at Newport Beach. The 21 miles of ocean shore line in the Basin include some of the most heavily developed beaches and recreational areas in the United States.

The Basin contains 46 sewered communities with a connected population of approximately 337,000 discharging wastes to the ocean, land disposal systems, dry watercourses, or to surface streams. Known industrial wastes with a population equivalent of 360,000, discharged to the Orange County Joint Outfall Sewer, increase this total to 697,000. There are 140 known industries in the Basin, but information is lacking as to the total pollutional load being discharged from industries.

Community waste treatment facilities serving the 46 sewered communities reduce the population equivalent of the combined domestic and industrial wastes from 697,000 to approximately 360,000. Of this total, 324,000 is discharged to tidal waters or directly to the ocean and 28,000 is discharged to land. Wastes with a population equivalent of only 3,700 are discharged from sewered communities to surface streams or watercourses. Additional wastes with a population equivalent of 4,400 are discharged to surface waters when not needed for irrigation.

Although the portion of the Santa Ana River having perennial flow is small compared to rivers such as the Sacramento, nevertheless, it is a significant proportion of the total length of the river in the valley and constitutes an important part of the water supply of Orange County. Pollution of the stream through introduction of substances harmful to any of its many uses would be important. There is some danger of pollution to mountain streams, impounded or diverted for irrigation and domestic water supplies, through recreational use of catchment areas. There is also a significant impairment to mineral quality of underground waters in some of the underground basins due apparently to inorganic materials reaching the underground water. Marine salt water has intruded from one to three miles inland along 13 miles of the coastline of the Basin. Due to high coliform counts health authorities have considered prohibiting the recreational use of the beach in the vicinity of the Orange County Joint Outfall Sewer. Deforestation and overgrazing have supplemented natural erosion processes. The amount of sediment carried by streams at times reaches extreme proportions.

Protection and conservation of the water resources receive an unusual amount of study in the Basin. All of the 46 sewered communities have provided at least primary treatment for their wastes, 33 of which, with a combined population of 196,110 have provided complete treatment. Only six of the communities ordinarily discharge treatment plant effluents to surface streams or watercourses. Some of the completely treated and heavily chlorinated effluent is used for irrigation during most of the year. Twenty-five of the communities dispose of their wastes to land, either prepared percolation beds or sewage farms, and the remaining 15 discharge to tidal waters or the ocean.

Many of the industries in Orange County now discharge to the ocean through the Joint Outfall Sewer. Most of the industries in Riverside and San Bernardino Counties dispose of their wastes to land, but information is not complete as to the industrial waste treatment facilities that have been provided. There has been some impairment of mineral quality of the underground waters in certain areas causing concern among officials and private individuals interested in water conservation. In some cases industries are now hauling their more objectionable inorganic wastes to disposal points on the Los Angeles County Sanitation Districts System or the Orange County Joint Outfall Sewer for disposal to the ocean.

Four new modern domestic sewage treatment plants were constructed and placed in operation during 1950 to treat the wastes from a combined population of 41,500. This activity in the pollution control field has been stimulated by two acts known as Chapter 47 and Chapter 20 passed by the California Legislature making a total of $100,000,000 available to cities and counties in California for postwar planning and construction of needed public works.

A great deal of work has been done by Federal, State, and Local agencies on conservation and protection of the underground water storage reservoirs of the Basin. Numerous reports have been written on the total capacity and yield of, and overdraft on, these basins. It is estimated that the average annual flow from the Santa Ana River to the ocean is from 20,000 to 30,000 acre-feet occurring at infrequent intervals during unusual floods. The normal function of the stream bed to serve as a drainageway to the sea is relatively less important in the case of the Santa Ana River, and its function as a natural spreading ground through which water and liquid wastes may percolate to underground reservoirs becomes relatively more important.

Bulletin No. 40 of the California State Division of Water Resources, 1933, reporting cooperative work with the U. S. Department of Agriculture indicates that ground waters of high salinity and high boron, sodium, sulphate, nitrate, and chloride content were found to occur in various parts of the Basin. Thousands of samples of water have been examined since 1933, and the Division of Water Resources is now compiling the information for publication.

Prior to 1949 the State Department of Public Health had primary responsibility for control of water pollution by means of a permit system. Following a two-year study by a legislative Interim Fact-finding Committee on Water Pollution, legislation was enacted in 1949 setting up a State and nine Regional Water Pollution Control Boards to control pollution and nuisance resulting from disposal of sewage and industrial wastes and to coordinate the activity of the numerous agencies involved in water pollution control.

The old permit system was repealed by the 1949 legislation, and the Regional Water Pollution Control Boards were made primarily responsible for water pollution control in all cases except those involving actual public health hazards. The new legislation also provides a sound technical basis for solution of water quality problems in the State by directing the State Division of Water Resources to conduct a continuing survey of water quality in the State with regard to pollution from all sources (Chap. 1552) and by authorizing the Regional Boards to require any State or local agency to inspect and report on any technical factors involved in water pollution or nuisance (Chap. 1549). Many studies and special investigations are being made by the Division of Water Resources and the Bureau of Sanitary Engineering under these provisions, but it is anticipated that several years will be required to complete comprehensive studies of the major water quality problems in the State.

On the basis of present information there are 23 communities and sanitary districts that need new or improved waste treatment works and that have in process some specific action for provision of the needed facilities. Five more communities or sanitary districts may need improvements to existing facilities but have taken no action toward provision of the needed works. In addition, there are 38 smaller communities which do not now have public sewer systems and which may require sewerage facilities in the not too distant future.

There are 140 known industries in the Basin. However, not enough information is available regarding industrial waste treatment to permit estimation of the number of industries that may need additional treatment facilities. In addition, a comprehensive survey of the industrial waste problem in the Upper Santa Ana River valley is required to show the need for construction of a sewer line to permit discharge of harmful chemical wastes directly to the Ocean to protect the mineral quality of the water resources.

The Orange County Sanitation District system should be completed to protect the Orange County beaches and steps should be taken to raise the ground water level in areas along the coast of the Basin to repel sea water intrusion.

CONCLUSIONS

(1) The greatest water use in the Basin is for irrigated agriculture followed by domestic water supply, industrial water supply, and sport fishing and other recreational use.

(2) Chronic shortages of fresh-water make pollution control of prime economic importance.

(3) Since surface water supply available for use in the Basin satisfies only 20 to 25 percent of the total demand, the balance coming from underground sources, quality of underground water is of greater region-wide significance than that of surface water.

(4) Protection of the quality of underground water supplies is of major importance because, once damaged, recovery may require many years instead of a matter of days as with surface waters.

(5) The more developed and densely populated portions of the Basin are located over or near important underground water supplies, thus making the latter susceptible to the influence of domestic and industrial wastes, particularly those containing significant amounts of dissolved chemicals.

(6) Surface water sources are confined mostly to mountainous, sparsely settled, recreational areas and are consequently exposed only to pollution from minor sewage disposal units. Increasing recreational use of mountain areas, however, makes the possibility of such pollution a matter of increasing concern and importance.

(7) At present impairment from organic sources of the quality of underground water in the Basin is insignificant.

(8) Impairment of the quality of underground water by inorganic substances shows a small but significant increase in large areas and has rendered well water completely unfit in some smaller areas.

(9) The possibility of "contamination" of underground water by sewage is believed to be slight at present, but rapid growth of many urban unsewered areas will require careful and constant scrutiny and long-range sewerage planning to minimize danger.

(10) Protection of the recreational value of the Orange County beaches is widely recognized to be of great importance to the Basin, as evidenced by county-wide planning for improving sewage disposal.

(11) With a few exceptions, community sewage disposal practices in the Basin are adequate for the present population or plans are underway for improvement.

(12) Population and economic growth of the Basin is increasing the domestic, industrial, and recreational uses of the presently available water supplies. The urgent need for wise utilization and conservation of existing sources of supply is thus emphasized.

(13) Watershed protection and water conservation receive an unusual amount of attention in the Basin. Experience indicates that in this area spreading of flood waters to recharge ground water basins is preferable to additional surface storage although a combination of surface reservoirs and spreading might prove to be advantageous in some instances.

(14) Important gaps exist in the information required by pollution control agencies. These gaps, including an evaluation of damages to ground waters by surface pollutants and the location and magnitude of industrial waste discharges, are being filled by studies and investigations authorized by recent State legislation.

RECOMMENDATIONS

(1) Communities and industries which have studied their waste treatment problems and have developed specific programs for solving them, and those for which requirements have been prescribed by State pollution control authorities should proceed at once with construction of the necessary treatment facilities.

(2) Vigilance should be maintained in preventing new sources and in eliminating existing proved sources of unreasonable impairment of underground water quality.

(3) Long-range plans should be made for waste disposal in the upper Santa Ana River valley including an industrial sewer to permit discharge of harmful chemical wastes directly to the Ocean.

(4) Comprehensive investigations, now being started, to fill the present gaps in information on pollution sources and damages therefrom should be encouraged and supported.

(5) Research programs on the technical problems of domestic and industrial waste treatment, including current studies on sea water intrusion and the effect of land disposal of wastes on subsurface water quality, should be encouraged and supported.

(6) Comprehensive plans should be made and regulations enforced for protection of water quality in recreational areas.

(7) The valuable beaches of the Basin must be protected by waste treatment and/or adequate ocean outfalls.

(8) Local, state and federal agencies should cooperate fully in expanding public information programs on the subject of water pollution.

GENERAL DESCRIPTION

Historical Background

The Santa Ana River Basin comprises parts of San Bernardino, Orange and Riverside Counties which were created in the years 1853, 1889 and 1893, respectively. These counties were originally parts of San Diego and Los Angeles Counties. (Plate 1, Appendix)

The first white men to visit the Santa Ana River valley were the Spanish explorers and missionaries Padre Francisco Garces, Fray Junipero Serra and de Anza in the latter part of the eighteenth century. The San Bernardino Asistencia to Mission San Gabriel, founded near Redlands in 1819, was the first white settlement in the area.

Jedediah Smith, the first American to enter California overland, followed the Mojave Indian trail into this Basin; and, in 1851, a colony of Mormons founded the City of San Bernardino on land purchased from the Spaniards.

Following the early Spanish-Mexican days, colonization proceeded rapidly. In 1857, Anaheim was founded by German settlers as an experiment in communal living. The town of Orange was founded in 1868, and Santa Ana during the next year.

The following historical sequence of events throws light on current conditions in the Basin. As early as 1854, six sawmills were operating in the San Bernardino Mountains; the discovery of gold in the mountain areas led to the influx of many prospectors; by 1860 ranges were overstocked and damaging overuse was the rule everywhere that forage could be found; during the period 1860-1900, newspaper accounts of great fires were common as were reports of floods caused by rainstorms on denuded watersheds; lastly, no organized fire control existed until the creation of the San Gabriel Timberlands Reserve in 1892.

Historical changes by nature and man have caused the conifers to recede and to decrease in density. Woodland and mixed chaparral type covers have probably changed. Erosion has been accelerated and the watershed abused during the past century. Pedro Fonts' diary describes the Santa Ana River where de Anza's Expedition crossed it in 1775 near the present site of Riverside: "The Santa Ana River is a stream with plentiful water and a very deep channel, being only some four or five varas* wide, six at the most in all this vicinity, but it is so deep that it has very few and difficult fords because of the rapidity with which the water runs. The waters of the river are very crystalline and beautiful."

Modern soil conservation and agricultural practices have done much to conserve land values and to assure a progressive economic development in the future.

Physical Description

Geography - The Santa Ana River Basin boundaries coincide with those of State Water Pollution Control Region No. 8. The Basin is bounded on the north by the Mojave River drainage area, on the east by the Whitewater River drainage area, on the south by the drainage areas of the Santa Margarita River and several coastal streams, and on the west by the San Gabriel River drainage area. The boundaries of the watershed in the coastal plain are not marked by prominent geographical features.

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*One vara - 33.38 inches.

To avoid dividing local administrative units, such as cities, sanitation districts, etc., the Los Angeles, San Diego and Santa Ana Regional Water Pollution Control Boards have agreed on common boundaries which give the Santa Ana River Basin an area approximately 300 sq. mi. larger than the watershed area of the Santa Ana River. The easterly boundary of Los Angeles County is being used as the common boundary of the Los Angeles and Santa Ana Regions. The San Gabriel River from the coast to the junction with Coyote Creek and Coyote Creek through almost its entire length, follow the Los Angeles-Orange County Line very closely, making these watercourses the joint responsibility of the two Regional Boards.

The Santa Ana River Basin is roughly rectangular in shape. It averages 60 mi. long by 45 mi. wide, and the point furthest inland is only 80 mi. from the ocean. The Basin area is approximately 2,784 sq. mi. Of this area 1,230 sq. mi. are in Riverside County, 1,000 sq. mi. are in San Bernardino County, and 554 sq. mi. are in Orange County. (Table 1, Appendix)

Topography - The Basin is dominated on the north and east by the high, rugged San Gabriel, San Bernardino, and San Jacinto Mountains, characterized by narrow, deep canyons, steep gradients, and rough terrain. Elevations range from 1,700 ft. at the base of the mountains to over 11,000 ft. at San Gorgonio Peak. The Basin contains about 1,135 sq. mi. of mountains and hills, 1,265 sq. mi. of valley and 384 sq. mi. of coastal plains.

The portion of the large alluvial-filled valley which lies between the Santa Ana River and the mountains to the north is known as the Chino or Cucamonga basin in the western part, and as the San Bernardino Valley in the eastern part. The bedrock floor of this basin is buried to great depths, generally in excess of 1,000 ft., under material transported from the mountains.

The San Jacinto basin, in the southeastern part of the valley area, was formed by the eroded material from the surrounding mountains, broken by numerous isolated mountains of low relief. The alluvial fill is relatively shallow with much more moderate slopes than in the basins below the San Gabriel and San Bernardino Mountains. The Perris peneplain, located between San Jacinto and Chino basins, is a triangular area of granitic rock eroded to moderate relief.

The Santa Ana River in its passage to the ocean has cut a gorge 12 mi. in length through the northern flank of the Santa Ana Mountains. This gorge separates the Santa Ana Mountains from the Puente Hills on the north. These hills are rounded and of moderate relief. A broad featureless plain forms the lower portion of the watershed, extending from the southern base of the Puente Hills and the Santa Ana Mountains to the ocean.

The slope of the Santa Ana River ranges from a maximum of 1,000 ft. per mi. at its headwaters to five ft. per mi. at its mouth. The average slopes are 240 ft. per mi. in the mountains and 26 ft. per mi. in the valleys. The average slopes of the tributaries range from 400 to 1,000 ft. per mi. in the mountains and from 23 to 175 ft. per mi. in the valleys. (Table 2, Appendix)

Geology - The southern California area, during Cretaceous and Tertiary periods, was inundated by the sea at several different periods and for varying lengths of time. The sediments deposited during these periods vary greatly in thickness and lithological character.

The San Gabriel and San Bernardino Mountains are made up of a large number of formations which, for convenience, have been grouped together and referred to as the Basement Complex. It includes the oldest rocks in the watershed and is composed of schists, gneisses, granites, diorites, quartzites, and limestone. The San Jacinto range and the mountain-like hills scattered throughout the southeastern part of the watershed are less complex and principally granitic in character.

Major fault lines cross the watershed in a northwest-southeast direction. The most important fault, the San Andreas, separates the San Bernardino Mountain block from the San Gabriel and the San Jacinto ranges. The San Jacinto fault extends diagonally into the southeast corner of the watershed. Smaller faults are of widespread occurrence throughout the watershed, but they are particularly noticeable in the San Gabriel and San Bernardino Mountain blocks.

All streams in the valley sections at present appear to be aggrading. The flow from large storms accomplishes considerable scour, but the great number of small storms more than compensate for this, and the net result is gradual aggradation.

The streams of the watershed have produced great natural underground water storage reservoirs by filling the bedrock basins with detritus eroded from the surrounding mountain areas. The many faults have pronounced effect on underground storage. The faults, which cut through alluvium layers, form nearly impermeable barriers to the free movement of underground water and create many basins in the larger alluvial fills. The best known example is the Bunker Hill Dike, which separates groundwater supplies in the San Bernardino basin from those in the Chino basin. These faults have produced some artesian areas and aquifer leakage which helps to produce year-long water flow in upper reaches of Warm Creek, Chino Creek, and similar valley streams.

On the basis of topography and land use, the soils of the watershed have been separated into two groups, namely mountain soils and valley soils. Table 3, Appendix, gives the characteristics for mountain soils of the watershed soil groups. Information on agricultural soils, based on U. S. Department of Agriculture reports, is given in Table 3.

Climate - The moist wind and fog from the ocean moderate the climate of the Santa Ana River Basin. Yearly mean temperatures throughout the region are approximately 63° F. with the exception of localities above 4,000 ft. where yearly mean temperatures are about 53° F. The average temperature at Riverside for 66 years of U. S. Weather Bureau records is 51.9° F. for the month of January and 75.8° F. for the month of July. Temperatures as high as 116° F. and as low as 6° F. have been recorded in the area.

A pronounced rainy season from December to March, when 75 percent of the yearly precipitation occurs, is followed by an equally pronounced dry season during the summer months. The total precipitation varies in a general cyclic pattern but the yearly mean is quite consistent over the valley areas, ranging from 11.3 in. per year at Riverside (elevation 895 ft.) to 16.9 in. per year at San Bernardino (elevation 1,172 ft.). In general, precipitation increases with altitude to a high of 47.6 in. per year at Kelly's Kamp (elevation 8,300 ft.). (Table 4, Appendix)

Snowfall in the higher regions represents from one-eighth to one-third of the total precipitation in these regions and remains until April or May in sheltered places.

The prevailing winds are westerly and usually of moderate velocity. During fall, winter, and spring months there are occasional northeast winds of high velocity. These winds, known as "Santa Anas," reach 50 to 75 mi. per hour velocities and are the cause of most of the wind erosion found in the Basin.

Along the immediate coast, morning fog limits the sunshine received to less than 60 percent of the possible amount. Within ten miles of the coast this figure increases to 75 percent which is representative of the sunshine received by the Basin in general.

Growing seasons range from 330 days at Anaheim to 151 days at Idyllwild. The average growing season for areas below 1,300 ft. is 287 days.

Hydrology - Stream flow is intermittent and subject to wide seasonal variations. Almost all stream beds are dry during summer and fall seasons except the larger ones in the mountains.

Water resources have been developed in the Basin to such an extent that nearly all stream flow, with the exception of infrequently occurring floods, is diverted for irrigation or ground water replenishment.

Summer flow in the main stem of the Santa Ana River is confined to that reach through the Santa Ana Mountains between Riverside and a point below Prado Dam. The average summer flow for this section of the Santa Ana River (1919-46) was 62 c.f.s.

Most tributaries have perennial flow from the mountains but during the summer months this flow is diverted for water supply, or if not diverted, percolates to the ground water before reaching the main stem of the Santa Ana River. Warm Creek, which originates mainly in the valley, has perennial flow which, during the irrigation season, is diverted before its confluence with the Santa Ana River.

The mountains that surround the valley are steep and rocky. Although only 41 percent of the area is mountainous, probably two-thirds of the total precipitation falls in the mountains and considerably more than two-thirds of the total run-off originates there. The storms are often heavy, concentrating a large part of the season's rainfall in a few days. Flood waters discharge from the canyon mouths onto the gravel cones of the valleys and percolation of these flood waters into the ground water basin constitutes the greater part of this supply. (Tables 5 and 6, Appendix)

The geological development of the region created impervious basins filled with porous material to a depth as great as 1,400 ft. Various faults crossing the valley have created barriers which retard the movement of underground water and generally hold the water table near the ground surface. The total ground water storage capacity of the Basin, exclusive of the San Jacinto basin, for a zone with average thickness of 100 ft. extending 50 ft. above and 50 ft. below the normal water level is estimated at 3,410,000 acre-feet. (Table 7, Appendix)

Economic Development

The population of the Basin was approximately 57,000 in 1900 and 345,000 in 1940 as compared to 1,485,000 in 1900 and 6,907,000 in 1940 for the State of California. The increase in population in the Basin for this 40-year period was 511 percent as compared to 365 percent for the State. (Tables 8 and 9, Appendix)

In 1950, the population of the Basin was approximately 576,000, an increase of 67 percent since 1940, and the State population was approximately 10,472,000, a corresponding increase of 52 percent. The growth after 1940 was caused partly by World War II. Military personnel in large numbers were stationed near Orange, Riverside, San Bernardino, and Santa Ana, and many civilians from outside the Basin were employed in local war plants. Many of these newcomers have established homes in the area.

Approximately 70 percent of the inhabitants live in cities and towns, and about 50 percent live in the ten largest cities. The 1950 population of the principal cities is given below:*

City	Population	City	Population
San Bernardino	62,694	Anaheim	14,522
Riverside	46,399	Colton	14,382
Santa Ana	45,534	Fullerton	13,939
Ontario	22,820	Newport Beach	12,220
Redlands	18,407	Orange	10,053

The rate of population increase for the Santa Ana River Basin since 1900 has been greater than for the State due to a distinctive preference on the part of newcomers for Southern California. It is estimated that of all the new businesses established in the United States since the end of the war, one out of eight has been located in Southern California. This trend probably will continue and as the remaining industrial and residential areas in Los Angeles County are developed, more and more industries and families will settle in the adjoining counties of the Santa Ana River Basin. The population forecast for 1960 is over 800,000.

Industrial activity in the Basin is second in importance to agriculture. The total value added to products by manufacture was $134,579,000 in 1947. Industries concerned with the processing and handling of food and food products paid a greater amount in wages in 1943 than did any other industrial group. The primary activity in the food handling group is the packing and processing of citrus fruits.

The largest single industry in the Basin is the Kaiser steel plant near Fontana which represents an original capital investment of $110,000,000 plus a recent R.F.C. loan of $11,500,000. This plant has a capacity of 700,000 tons annually and employs 2,500 persons.

Other important industrial activities in the area are: mining, petroleum production, making of Portland cement, the manufacturing of canning and packing machinery, the manufacturing and repairing of transportation equipment, and the manufacturing of chemical and metallurgical products.

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*Data provided by the San Francisco Office of the U.S. Department of Commerce, Field Service.

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With the exception of food and food products manufacturing, the general level of industrial activity in the Basin is fairly uniform throughout the year. The food industry is dependent upon the harvest season but the mild climate has dampened the fluctuation by providing several harvests per year. The number of business establishments in the counties, parts of which comprise the Basin, approximately doubled during the period 1939-1947. It is likewise significant that the value in dollars added by manufacture was quadrupled during this period. (Tables 10, 11, and 12, Appendix)

The labor force in the Basin consists primarily of semi-skilled and unskilled farm laborers plus a permanent group of factory workers and sales and service personnel. The transient labor problem is partly alleviated by a year-round agricultural program which tends to level off the employment curve. During the period 1939 to 1947, the number of production workers in Riverside, San Bernardino and Orange Counties increased from 6,050 to 16,861, the total wages for 1947 amounting to about $30,000,000 (Census of Manufactures, 1947).

Agriculture is the primary economic activity of the Basin. Citrus fruit growing and packing leads the list of agricultural pursuits. It is closely followed by the production and marketing of deciduous fruits, nuts, wine grapes, field and truck crops, poultry, honey, livestock, and dairy products. (Tables 13 and 14, Appendix)

There are approximately 430,000 acres under cultivation in the Basin equivalent to nearly 25 percent of the total acreage. The climate of the area is so well suited to agriculture that six or seven cuttings of forage crops can be obtained each year. Year-round citrus production is possible with grapefruit ripening in the summer, Valencia oranges from late spring to early winter, Navel oranges in the winter and lemons throughout the year. (Table 15, Appendix)

The Basin is well supplied with non-metallic minerals. Limestone, clay and gypsum deposits furnish the raw materials for two large Portland cement plants. High grade clay in Orange and Riverside Counties supplies material for fine china, refractory brick and other manufactured clay products. Aggregate and building stone are quarried in several places in the area.

Although San Bernardino and Riverside Counties are both rich in metallic minerals, the portions within the Basin boundaries are relatively barren and the only metals mined in the area are small quantities of gold, silver, lead and zinc. (Table 16, Appendix)

Timber production in the Basin is relatively unimportant as most of the accessible timber land was cut over by the early settlers. Six sawmills are reported to have been in operation in the San Bernardino Mountains as early as 1854. Also, much valuable timber land was burned over since there was no organized fire control until 1892.

In 1948, there were only five registered sawmills in San Bernardino County, one in Riverside County, and none in Orange County. Total reported production was 2,500 M.B.M. (thousand feet board measure) of saw logs and 750 cords of fuelwood in San Bernardino County and 250 M.B.M. of saw logs in Riverside County.

All of the petroleum production of the Basin is concentrated in the coastal plain area of Orange County principally in the Seal Beach, Huntington Beach, Newport, West Newport, East Coyote, West Coyote, Richfield, and Brea-Olinda Fields. The petroleum production in 1947 was 29,399,000 M. cu. ft. of natural gas valued at $2,465,000; 4,528,000 gal. of liquified petroleum gases valued at $150,000; 115,423,000 gal. of natural gasoline valued at $5,911,000; and 34,146,000 bbl. of petroleum valued at $58,274,000. Total value of all petroleum products in Orange County in 1947 was $66,800,000 as compared to a value of $63,698,723 for all farm products raised in Orange County; $55,953,450 for all farm products in San Bernardino County; and $45,798,101 for all farm products in Riverside County in 1945. (Tables 14 and 16, Appendix)

Principal game species in the Santa Ana River Basin include doves, ducks, brush and cottontail rabbits, quail and jack rabbits. In general, their numbers are low in comparison with State averages.

The dove kill, which was approximately 60,000 in 1948, is largest along the Santa Ana and San Jacinto Rivers, at Lake Elsinore and in the hilly area between March Air Force Base and the Santa Ana River. In 1948, about 41,000 ducks were taken, principally in the coastal area, along the Santa Ana River, and at Big Bear and Elsinore Lakes. The quail population, including both valley and mountain quail, is scattered throughout the Basin, the estimated 1948 kill being around 31,000. Band-tailed pigeons are found in the mountains between Idyllwild and Beaumont, and at Arrowhead and Big Bear Lakes.

Jack rabbits are quite uniformly distributed in the open country and a small deer population occurs in the hilly parts of the Basin. (Table 17, Appendix)

Natural vegetative cover has been modified with the development of the Basin. While the pristine cover conditions are not well understood, certain dominant modifying factors are known. Thus, historical records show that, with the establishment of the Mexican regime, fires increased and ranges were quickly overstocked. Mountain logging, started by the Spanish Californians, became widespread during the period 1850-1860. Throughout the next forty years the number of livestock in Southern California was extremely high and overuse of forage resulted. Simultaneously, great fires swept uncontrolled over grass, brush and timberlands.

These elements of change and destruction to wildland cover have produced notable effects on the vegetative cover. The conifer, woodland and mixed chaparral types have receded. The most valuable litter-building species have decreased with repeated burnings. Conifers have undergone greatest reduction in area and density while chaparral has deteriorated due to a lowering of the height of the shrubs, a decrease in density, and a reduction in litter production.

In the valley areas farms, cities, highways, airfields and other developments have replaced large areas of natural cover. Approximately four percent of the watershed area is occupied by towns, lakes, and reservoirs whereas 25 percent is under cultivation. The remainder of the Basin is uncultivated, including most of the mountainous area, the valley hills, and the undeveloped alluvial slopes at the foot of the mountains. Here, there is a native cover that is a product of environmental conditions, overgrazing and devastating fires.

The chamise type prevails at lower elevations in the mountains. Its quick recovery and growth following fire is important for slope protection.

The sage-buckwheat type covers the undeveloped alluvial fans and a large part of the valley hills, merging with the chamise along the mountain front.

The chaparral-woodland type occupies a broad belt throughout the middle elevations in the mountain area. The principal species are mountain lilac, buckbrush, coffee berry, scrub oak, manzanita, mountain mahogany, toyon, wild cherry, and laurel sumac. Plants are from eight to 15 feet tall at maturity, form a dense impenetrable stand with a thick crown canopy, and produce an abundance of litter. As the elevation increases on northerly exposures or on moist sites, the chaparral merges almost imperceptibly into woodland, comprised principally of big cone spruce and the tree form of canyon live oak.

Coniferous forest occupies ridges and some of the higher valleys. It includes, ponderosa pine, Jeffrey pine, sugar pine, white fir, coulter pine, big cone spruce, and other species. This type has suffered greatly from the effects of repeated burns. Today there are almost as many standing snags as living trees of big cone spruce.

Excellent stands of ponderosa pine, sugar pine, white fir, or the mixed conifer type, occur on the plateau areas which were protected naturally from the devastating fires. On the exposed mountain slopes this type has been pushed back to the crests of ridges and to north slopes. Chaparral, both within and below the present timber type, occupies much potential timberland. At higher elevations and on steeper slopes this type is dominated by white fir. Fire has reduced the density of these stands to the extent that large areas now are unstable, semi-barren areas lacking the protection formerly afforded by trees and shrubs.

Subalpine forests of lodgepole and limber pines are found above the 8,500 ft. level. These stands are scattered and soil conditions are unstable. Climatic conditions are extreme. In its present decimated condition, both this type and the sugar pine-Jeffrey pine-white fir type are losing ground. Reproduction is inadequate to maintain the present mature and decadent stands.

Native cover types of the uncultivated land of the Santa Ana River watershed are listed below*:

Vegetation Cover Types	Area (Acres)	Percent of native cover type	Percent of total Watershed
Chamise	336,030	32.2	21.2
Sage and buckwheat	267,650	25.7	16.9
Chaparral and woodland	180,570	17.3	11.4
Coniferous forest	113,210	10.9	7.1
Grass	83,850	8.0	5.3
Barren and semi-barren	61,230	5.9	3.8
Total	1,042,540	100.0	65.7

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*Table provided by the San Francisco Office of the U.S. Forest Service.

USES OF WATER RESOURCES

In the semiarid climate of the Santa Ana River Basin, water is necessary for the irrigation of crops as well as for domestic, industrial and other uses. The relatively light rainfall and the difficulty of importing water from outside the area have resulted in the development of water conservation practices so effective that in very few other basins in the United States is equal efficiency attained.

Probably two-thirds of the total precipitation in the Basin falls in the mountainous area, and considerably more than two-thirds of the total run-off originates there. The upper Santa Ana River valley and the coastal plain form natural ground water storage reservoirs filled with absorptive alluvial deposits which hold the rainfall and run-off that percolates into them. The maximum thickness of these porous deposits is over 1400 ft., and the storage capacity of a zone 100 ft. thick extending 50 ft. above and 50 ft. below the normal ground water level is estimated at 3,410,000 acre-feet for the Basin exclusive of the San Jacinto basin (Plate 2, Appendix).

A considerable portion of the flood flow ordinarily finds its way through the porous stream bed materials to the underground storage basins, but spreading flood waters to enlarge the wetted area and increase the amount of water conserved is widely practiced in the Santa Ana River valley. This type of water conservation and flood control was first started on San Antonio Creek near Claremont in 1895. This creek was one of the two areas in Southern California where spreading flood flows to recharge the ground water was first practiced. Work was started on the spreading area for the Santa Ana River near Redlands in 1911 and for Lytle Creek at the mouth of Lytle Creek Canyon in 1925. The 12 principal spreading grounds constructed by local interests are listed in Table 18, Appendix. The approximate area of the spreading grounds was 12,050 acres in 1946 and the estimated cost $3,444,000. Much of the work was financed by local, state and federal relief agencies.

Extensive spreading of flood waters in the lower Santa Ana River valley is more difficult due to lack of areas where permanent diversion dams can be built without danger of channel changes damaging bordering land devoted to valuable citrus groves. From its natural course, some flood water percolates to the underground water through the porous stream bed material. In 1931, the Orange County Flood Control District started studying the behavior of the meandering flood stream in order to permit diversion of the flow over sand bars, within the banks, not normally covered by low flood flows. The percolation rates for the wetted stream bed area have been found to average 3.1 acre-feet per acre per day, but the additional area that can be wetted is restricted to the area between the present stream banks.

Run-off from the mountains and hills discharged to the interior valley and coastal plain of the Santa Ana River averages 240,000 acre-feet annually. An additional 30,000 acre-feet of run-off from the valley floor makes the total run-off 270,000 acre-feet*. Average annual waste to the ocean is only 20,000 to 30,000 acre-feet or one percent of the mean annual rainfall and less than five percent of the mean annual demand for water in the Basin. The possibility of salvaging part of the loss by surface reservoir construction has been studied by State and local interests, but the excessive cost of construction makes it unattractive.

In the Santa Ana River ground water basins, excluding Chino basin and basins tributary to it, outflow from upstream basins responds quickly to changes in water table elevation. In most of the upper basin, extraction of ground water could be increased without causing hardships within the basin; but this would decrease the normal outflow to the lower Coastal Plain by a corresponding amount. In studies of the overdraft on ground water basins, the California Department of Public Works, Division of Water Resources, has assumed the total overdraft to be in the Coastal Plain although the overdraft on the total Santa Ana River Basin is the same no matter what distribution is assumed**.

Outflow from the Chino basin and its tributaries also contributes to the flow of Santa Ana River, but no evidence has been found that the amount of flow is influenced by the elevation of the water table. The Chino basin is considered separately from the other basins of the Santa Ana River as lowering of the water table enough to decrease the outflow would increase the cost of pumping and automatically decrease the demand and overdraft on the ground water. The combined annual overdraft from the Chino basin is estimated to be about 21,000 acre-feet. Annual overdraft from the lower Santa Ana River basin was estimated to be 14,000 acre-feet in 1946, but increased importation of Colorado River water by the Metropolitan Water District of Southern California to Orange County since 1946 may have changed conditions to some extent.

Most of the cities and towns in the Santa Ana River Basin are located in the upper Santa Ana River valley or along the coastal plain where ground water supplies have been readily available. There are 37 communities including state institutions and Army, Navy and Marine Corps Bases where public water supplies are available for domestic use (Table 19, Plate 3, Appendix). All but one of these water supplies, serving a population of approximately 356,000 are taken, at least in part, from ground water sources. Total water consumption of the 37 communities is estimated at 66,000,000 gal. per day or 185 gal. per capita. Only part of the total consumption is for domestic use, the remainder being for irrigation and industrial purposes. The wells generally are from 200 to 800 ft. deep with a few reaching depths greater than 1,000 ft. The static water level is generally less than 300 ft. depending upon the location of the well with respect to barriers between the underground basins. Mineral quality of the water is very good as shown by the following range of analyses of samples collected from wells at Riverside*.

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*Water Supply and Use, Santa Ana River System, Report to Santa Ana River Water Association, Redlands by Harold Conkling, March, 1947.

**Bulletin No. 53, South Coastal Basin Investigation, Overdraft on Ground Water Basins, State of California, Department of Public Works, Division of Water Resources, 1947.

Total Hardness as $CaCO_3$	92 to 156 p.p.m.
Total Alkalinity	100 to 189 "
Chlorides	9 to 28 "
Sulfates	16 to 46 "
Calcium	31 to 49 "
Magnesium	6 to 8 "
Sodium	21 to 41 "
Iron	0 to trace

One community obtains all of its supply and six obtain part of their supply from local streams. The total population served of the seven cities using surface water for domestic purposes is 109,860. All of the surface supplies are chlorinated and at one supply, the city of Redlands, chemical coagulation and filtration are provided. The streams all drain mountainous areas and, when developed, were fairly well protected from contamination. Increased use of these areas for recreational purposes is making it more difficult to protect the supplies against pollution.

Six of the 37 communities are obtaining part of their water supply from the Metropolitan Water District of Southern California which imports water from the Colorado River. The following list shows the amount of water used from local well sources and the amount of water imported by these places in 1949:

	Acre-feet		Percent	
	Local	M.W.D.	Local	M.W.D.
Anaheim	138	2,575	5.1	94.9
C.M.W.D.**	4,209	2,741	60.6	39.4
Fullerton	1,975	1,276	60.8	39.2
Santa Ana	1,019	5,647	15.3	84.7
Total Imported		12,239		

Raw Colorado River water is also taken for March Air Force Base from the main aqueduct before it reaches Lake Mathews. The camp has five wells, but is located in a critical ground water area and uses imported water to conserve the ground water supply for other purposes. The water is softened in the treatment plant at nearby Camp Haan, now part of March Air Force Base.

The Metropolitan Water District of Southern California is a public corporation organized in 1928 under the authority of the Metropolitan Water District Act of California. The Act provides a means whereby groups of cities and certain other governmental subdivisions may join together in development of a common water supply.

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*State of Calif., Dept. of Public Health, Special Bulletin No. 63 California Water Supply Statistics, Based on Surveys of 1940.

**The Coastal Municipal Water District serves parts or all of Brea, Costa Mesa, Newport Beach, Laguna Beach, Dana Point and Irvine, and other unincorporated coastal areas of Orange County. Brea, Costa Mesa and Newport Beach are in the Santa Ana River Basin.

The District was organized for the purpose of supplying the area within its boundaries with an adequate water supply for domestic and industrial use. The main objective in forming the District was the construction of the Colorado River Aqueduct, not only to meet the immediate needs but to assure an adequate water supply for the Metropolitan Areas of Southern California for generations to come.

The main aqueduct, including tunnels, canals, cut-and-cover conduits, and inverted siphons actually used to transport water, as well as the five pumping plants, 230-KV power transmission system bringing power from Hoover Dam, the telephone system, one-half of the Parker power plant, the dams, reservoirs, roads, camps, etc., was completed in 1939 at a cost of over $140,000,000. Water is diverted from Lake Havasu at the intake two miles upstream from Parker Dam on the Colorado River and transported 242 miles to Lake Mathews located south of Riverside in Riverside County.

Construction of the distribution system to the original 13 areas, including 172 miles of conduction lines, reservoirs, and the softening plant at La Verne, was completed in 1941 at a cost of over $56,000,000. Several enlargements have since been made to serve additional areas. The water from the Colorado River is much harder than the natural waters in Southern California and is softened by the lime-zeolite process to make it more acceptable to the consumers. Raw water during the 1948-49 season averaged 334 p.p.m. total hardness and the treated water 133 p.p.m.

All of the areas that are using water from the M.W.D. are doing so because local ground water sources are no longer adequate for the rapidly growing population. Most of the communities are located in the coastal plain where there has been an overdraft on the ground water supply for many years and where salt water intrusion has already ruined many wells. Importation of softened Colorado River water into the Basin totaled 10,449 acre-feet in 1945-46; 10,837 acre-feet in 1946-47; 12,103 acre-feet in 1947-48; and 12,239 acre-feet in 1948-49*.

With only 358,000 persons out of a total estimated (1950) population of 575,942 using water from public supplies, the remaining 217,942 must rely on private or semi-private water supplies. There are over 200 water companies supplying water for agricultural purposes in the Basin, and many people use these supplies for domestic purposes. The water is so costly that it is usually distributed through closed systems, but delivery is made only once or twice a week. In order to have a continuous domestic supply, water is stored in a cistern or storage tank at each home. Those supplies having less than 200 service connections have not been required by law to obtain permits from the State Department of Public Health. Most of the water for the small water companies comes from wells, but a small part comes from mountain streams or surface reservoirs. The larger surface reservoirs are listed in Table 20 and are shown on Plate 1, of the Appendix.

Generally, industries located in areas served by public water supplies use these supplies. Industries located outside areas served by public water supplies either obtain their supply from private water companies or have their own wells. Most of the industries as well as municipalities depend upon ground water supplies, and the ground water in almost all areas is of satisfactory quality for industrial use.

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*From Annual Reports of the Metropolitan Water District of Southern California, Los Angeles.

In the semiarid climate of the interior valley and coastal plain areas of the Santa Ana River Basin, water is necessary for irrigation of crops on approximately 300,000 acres of land. In this area only grapes and some low-value field crops are dry farmed. The average annual duty of water in the area ranges from 1.5 acre-feet an acre for orchards to 3.0 acre-feet per acre for alfalfa, sugar beets, and truck crops. Of the 683,000 acre-feet of water used annually in the Basin, only 43,000 acre-feet is used for domestic and industrial purposes while 640,000 acre-feet is used for irrigation*.

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The cost of water ranges from about three dollars an acre-foot for irrigation supplies diverted from surface streams to about $40 an acre-foot for domestic and industrial water used in urban places. Assuming the average cost of water for irrigation and urban use is nine dollars and $35 an acre-foot, respectively, the total value of water used in the Basin is more than $7,000,000 annually*.

From 20 to 25 percent of the water used in the Basin is diverted from reservoirs and surface streams, and the remainder is pumped from wells. There are nearly 200 water companies and districts distributing water for irrigation and other uses and in addition hundreds of farmers obtain their water supply from wells on their own property. The water systems within the drainage area include 22 diversion dams, 130 reservoirs (mostly small), 200 miles of canals, more than 2,800 miles of pipe lines, 2,500 wells, and many water-spreading areas.

Most of the local water supply in the Basin is used by organizations or individuals under water rights established by long usage, court decrees, or compromise agreements. During the period of colonization in the last part of the nineteenth century, the formation of groups of landowners into companies to obtain water rights and to distribute water was the necessary first step in the extensive development of new land. Rights were first established for the normal surface flow of all streams and later for pumping from wells in or near the stream beds.

Mr. Henry Holsinger, Principal Attorney for the Division of Water Resources, summarizes California State laws regarding rights to underground water as follows:

"Rights to pump water from all other points in the underground basin (at all points where the existence of a definite underground watercourse cannot be established) are acquired under California State water laws, either by appropriation, or by acquisition of land and use of water thereon pumped from underlying water-bearing strata. The land is referred to as overlying land and the right to the use of water as the overlying right. The right extends only to a reasonable share of the water correlative with the like right of other overlying owners. Appropriative rights may be acquired by use but are limited to a surplus in excess of all reasonable requirements for beneficial use by overlying owners and prior appropriators. Use of the water is not restricted to the overlying land. Such appropriations may be made by overlying owners or by anyone acquiring lawful access to the overlying land. Overlying rights are generally paramount to appropriative rights unless the appropriative right becomes vested against an overlying owner by prescription."*

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*From Department of the Army, Corps of Engineers Reports.

Downstream water users, especially those on the coastal plain, have objected to the extensive diversion of stream flows into spreading grounds at the base of the mountains. Much litigation has resulted from the objections. The rights for spreading on the debris cones of Santa Ana River, Mill Creek, and Lytle Creek were adjudicated in 1942 court decisions in the form of three decrees, one for each stream. The effect of these decrees is to prevent large increases in the quantity of water spread on those cones. The only unappropriated waters are from rare floods that reach the ocean. These waters have not been used because they cannot be conserved at reasonable cost.

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The overdraft on the coastal plain would be greater than at present if some of the water supply for part of the area were not imported from the Colorado River. In addition to the softened water used by municipalities in the coastal plain, 11,000 acre-feet of raw water was purchased during the 1949-50 season from the Metropolitan Water District and released to the Santa Ana River near Arlington where the main aqueduct crosses the river. Some of the water was spread on percolation beds to recharge the ground water and some was diverted directly to the Anaheim Union Water Company and Santa Ana Valley Irrigation Company irrigation systems in order to reduce the overdraft on ground water basins.

The Santa Ana River Basin supports an important sport fishery. An estimated 90 percent of the fishing effort by sportsmen is salt water shore and boat fishing, mainly for kelp bass, sand bass, kingfish, surf perch, corbina, spot fin croaker, halibut, barracuda, mackerel, white sea bass, and bonito. Off-shore fishing boats run from Newport, Balboa and Huntington Beach, mostly from April to October.

An indication of the intensity of the marine sport fishing on this part of the coast is provided by the catch records for the area between Dume Point, at the northern extremity of Santa Monica Bay and San Mateo Point, at the coast boundary between Orange and San Diego Counties (Region 7 of the Bureau of Marine Fisheries of the California Division of Fish and Game). According to the reports of the California Division of Fish and Game, there were 174 pleasure fishing boat operators in this particular region of the coast during 1947.

Marine sport fish catch records for Region 7 during 1947**:

Number of anglers	367,166
Number of fish	2,071,644

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*From private correspondence.

**Data provided by the California Division of Fish and Game.

Weight of fish (lbs)	6,778,818
Catch per man-day by number	5.4
Catch per man-day by weight (lbs.)	18.46

Within the coastal area of the Santa Ana River Basin, Newport Beach is the principal landing port. Here, the largest catches are made during the months of May, June, July and August and the total catch during the period May 1949 to April 1950 was 325,014 fish. On a basis of annual totals, the fish caught in largest numbers are kelp bass, barracuda, California halibut, Pacific mackerel, and white sea bass. (Table 21, Appendix).

Inland centers of greatest fishing intensity are Big Bear Lake, Upper Santa Ana River, City Creek, Lytle Creek, Mt. San Jacinto area, and Lake Hemet. The most important fresh-water angling is stream fishing for trout, although lake fishing in Big Bear Lake is very popular. Altogether there are only about 20 streams in this Basin that support a significant fishery. Insufficient water largely restricts fishing in streams to altitudes above about 4,000 feet. (Plate 4, Table 22, Appendix).

The trout fishery is dependent almost entirely upon hatchery raised fish. The streams are stocked with catchable size trout and some streams are restocked as often as every three weeks during the height of the season. Most of the stocking in Orange, Riverside and San Bernardino Counties is done within the Santa Ana River Basin. In 1948, the California Fish and Game Commission stocked the waters of this area with over 300,000 catchable size fish weighing about 44,000 pounds.

Principal commercial fish landings on the coast of the Santa Ana River Basin are at Newport Beach. In 1947, approximately 14,500,000 pounds of fishing products valued at $747,000 were landed at this port. The largest landings are made during the months of October, November, December and February. The kinds of fish providing the most valuable catches are Pacific mackerel, broadbill swordfish, albacore, sardine, barracuda, and shark. (Table 23, Appendix).

The 42 miles of ocean shoreline in Orange County, 21 of which is in the Santa Ana River Basin, is of major importance as it includes some of the finest and most heavily developed beaches and other recreational features to be found in the United States. In addition to the extensive use of the beach areas by Orange County residents, they are used to a great extent by people from Los Angeles County and elsewhere. Seal Beach, Sunset Beach, Huntington Beach, and Newport Beach are as close to some of the large population centers of Los Angeles County as they are to the main population centers of the Basin, and with the existing highway systems, are actually more accessible to Los Angeles people.

The summer attendance at Huntington Beach was approximately 950,000 people in 1940 with winter attendance swelling the annual total to 1,108,000. Of this total, seven percent were local Huntington Beach residents, 35 percent were from other places in Orange County, 35 percent were from Los Angeles County, and 23 percent were from other counties and states. It has been estimated that in 1946

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*Data provided by the California Division of Fish and Game.

20 million visits were made to the beaches in Los Angeles and Orange Counties and that on a typical Sunday or holiday 250,000 people may use the beach facilities in Orange County alone.*

Future beach attendance is expected to increase, roughly in proportion to the combined population of Orange and Los Angeles Counties, to some saturation limit determined by the miles of shoreline available for use. Recognizing the importance of the beach areas in Orange County, the Board of Supervisors in 1941 adopted a master plan of beach development prepared by the Orange County Planning Commission. Of primary importance to the plan is assurance of a shoreline free from sewage pollution.

Principal inland recreational areas of the Basin are the mountainous regions which include parts of the San Bernardino and Cleveland National Forests. The extent of the use of the alpine areas is indicated by the man-days recreational use for San Bernardino National Forest that totaled 2,206,050 in 1948. In addition to intensive trout fishing in the limited mountainous parts of the Santa Ana and San Jacinto Rivers and their tributaries, there is considerable boating and other recreational use made of Big Bear Lake, Lake Elsinore and Hemet Lake, as well as of several reservoirs (Plate 4, Appendix).

In general, the demands for recreational developments in the Basin far exceed the existing facilities, an expected condition because of large, nearby urban centers. The streams are greatly overfished, a condition that requires constant stocking with catchable size fish throughout the summer. Water shortages with accompanying fire hazards necessitate closing the National Forests in summer and early fall. Other recreational facilities become increasingly overcrowded and the protection of the water supplies against pollution is correspondingly difficult and important.

Low-cost electric power is available in the Santa Ana River Basin from the Hoover Dam plant on the Colorado River, from steam plants located near Long Beach, and from 11 hydroelectric plants on mountain streams in the Basin. All power generated at the 11 hydroelectric plants is distributed by the Southern California Edison Company which owns 10 plants and leases one from the Fontana Power Company.

The Metropolitan Water District of Southern California, through contracts with the U. S. Bureau of Reclamation, will be alloted a minimum of 1,375 million kilowatt hours of the firm power at Hoover Dam annually until 1987 and receives in addition 300 million kilowatt hours per year of energy generated at Parker Dam. This power is sufficient to pump 800,000 acre-feet of water annually through the aqueduct lift of 1,617 ft. Colorado River water consumption by the Metropolitan Water District constituents was only 144,787 acre-feet in 1948-49. Surplus power totaling 1,170,052,576 kilowatt hours was resold to the City of Los Angeles and to private power companies at the firm rate of 1.298 mills per kilowatt hour**.

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*Orange County Sewerage Survey, 1946-1947. Report upon the Collection, Treatment, and Disposal of Sewage and Industrial Wastes of Orange County, California. Board of Consulting Engineers, A. M. Rawn, Chairman, June 30, 1947.

**Eleventh Annual Report of the M.W.D. of Southern California, 1949, Los Angeles.

POLLUTION CONTRIBUTED TO WATER RESOURCES

The Santa Ana River Basin contains 46 sewered communities with a total connected population of approximately 337,000 discharging domestic and industrial wastes to surface streams or watercourses, to land disposal systems, or to the Pacific Ocean (Table 24, Appendix). Known industrial waste discharges with a population equivalent of 360,000 to the Orange County Joint Outfall Sewer increase the total population equivalent of the raw sewage to 697,000. Ten of the 46 communities discharge their wastes to the Orange County Joint Outfall Sewer; one, the Norton Air Base, is included with San Bernardino; and one, the city of Upland, is included with the city of Ontario. Eight of the communities are Defense Department installations, many of which were staffed with skeleton forces only at the time of this survey.

The population equivalent, after treatment, of the wastes from 46 sewered communities is approximately 360,000. Of this total, 3,700 is discharged to surface streams or watercourses; another 4,400 from the city of San Bernardino is discharged to Warm Creek, and reaches the Santa Ana River when not diverted for irrigation; 28,000 is discharged to land, either irrigated fields or percolation beds; and 324,000 is discharged to tidal waters or direct to the Pacific Ocean. (Plate 5, Appendix)

Sewage or sewage effluent is being discharged to the ocean or to tidal waters at six places in the Basin, namely, Seal Beach, Seal Beach Navy Net and Ammunition Depot, Los Alamitos Naval Air Station, and Sunset Beach in or near the mouth of the San Gabriel River; and Huntington Beach and the Orange County Joint Outfall Sewer, the former in, and the latter near, the mouth of the Santa Ana River. Compared to the population equivalent of the wastes discharged at the Orange County Joint Outfall Sewer, the wastes discharged at other points in the Basin are relatively insignificant. (Plate 5, Appendix)

The total population of the Basin was estimated at 576,000 for 1950 of which approximately 337,000 are connected to public sewer systems. The remaining 239,000 use private methods of sewage disposal, usually cesspools or septic tanks and subsurface percolation beds. Pollution from these private disposal systems may reach the ground water supply in some cases.

Pollution from sewerage systems serving recreational camps in the mountainous areas may also reach surface water used as public water supplies. There are many of these camps located on the watershed of the Santa Ana River, mostly in the Barton Flats, Mill Creek, and Big Bear Lake areas. The camps are able to accommodate from 150 to 400 children each and there may be as high as 10,000 campers in the area during the peak summer season. Most of the camps are on national forest land and applications have been made with the Forest Service for permits to establish 70 additional camps.

There are 140 known industries in the Basin that may have industrial waste disposal problems, but a great deal of additional information is required in order to accurately evaluate the pollution being contributed to the water resources. Location of these known industries is shown on Plate 6, Appendix. The quantity of liquid wastes, tons B.O.D., and population equivalents for the industries in Orange County are also shown in Figures 1 and 2, Appendix.

The industries may be grouped as follows:

Food processing plants - There are 48 known plants of this type in the Basin. Most of those located in Orange County either now discharge their wastes to the Joint Outfall Sewer or will be connected to the new Orange County Sanitation District system. Those located in Riverside and San Bernardino Counties generally dispose of their wastes by ground disposal methods.

Most of the plants process citrus fruits although some other fruits, vegetables, nuts, and olives are processed. The Exchange Orange Products Plant at Ontario, one of the largest plants, disposes of liquid wastes with a population equivalent estimated at 125,000, to land. The Exchange Lemon Products Plant at Corona also disposes of liquid wastes to percolation beds. Some of the smaller plants such as the K. & R. Fruit Products Company at Upland with a capacity of 30 tons per day of oranges or tomatoes, and the Del Rosa Olive Packing Plant near San Bernardino with a capacity of 125 tons of olives per year, discharge liquid wastes to dry watercourses where they percolate into the stream bed within a short distance.

There are no large meat packing plants in the area as stock raising is not one of the principal industries of the Basin. There are five known slaughterhouses included with the 48 food processing plants such as the Pliny Cross Company near Colton with a capacity of 35 horses daily and the Swift Duckling Farm near Fontana with a capacity of 10,000 ducks, turkeys, and chickens daily. The slaughterhouses generally discharge their liquid wastes to land or dry watercourses.

Several miscellaneous organic waste producing plants such as the Fontana Farms Company Hog Ranch near Fontana and the Holly Sugar Company in Orange County are included with the food processing plants. The hog ranch is a large operation feeding 40,000 hogs on 360 tons raw garbage daily from the Los Angeles metropolitan area. Wastes from the Holly Sugar Company with a population equivalent of 120,000 are discharged after treatment to land.

Marketable oranges as well as some other citrus fruits are packed for shipment at numerous small packing plants throughout the citrus growing areas of the Basin. Since there is little waste from these plants other than wash water, they are not included with the fruit and vegetable processing plants. The wash water does create a waste disposal problem, however, due to the high boron content. Compounds containing boron are used extensively in cleaning oranges before packing as the small amount of boron remaining on the orange skin is very effective in preventing fungus growth and spoilage of the fruit.

There are six citrus packing plants in Highland which are estimated to pack ten percent of the orange crop in San Bernardino County. The liquid wastes from these plants are discharged to an open storm ditch which drains to a dry creek bed. There are 13 orange packing plants in the city of Riverside, nine of which discharge to the domestic sewer system. The 13 plants pack 30 cars of fruit daily using 700 gallons of water and 46 pounds of boron compounds per car. The boron content of the Riverside Municipal Sewage Treatment Plant effluent averages from one to two p.p.m. with occasional values as high as five p.p.m. The boron content of the city water supply [illegible] only 0.2 p.p.m. Most of the boron used in Riverside and San Bernardino Counties, either for domestic or industrial purposes, will eventually reach the ground water as there is normally little surface run-off from this area.

Wineries - There are 31 bonded wineries and 18 bonded fruit distilleries in the Basin mostly grouped around Cucamonga in San Bernardino County. The wineries are generally located in rural areas and process grapes grown in surrounding vineyards. In the bonded wineries which produce dry wine, the solid waste (pomace) is spread on the vineyards as fertilizer, and liquid waste from washing and cleaning operations is usually used for irrigation. The fruit distilleries differ from ordinary wineries in that brandies and sweet wines are produced in addition to dry wines. The liquid still-slops from these plants present a very serious disposal problem as they cannot be used for irrigation. The slops are usually kept separate from other liquid wastes and discharged to lagoons from which they enter the subsurface water and occasionally spill to surface streams. The total grape production in San Bernardino County in 1939 was 87,600 tons of which it is estimated 85,000 tons were made into wine.

Dairies - There are 19 large dairies in the Basin processing milk products. Many of the plants are no doubt discharging wastes to public sewer systems adversely affecting the treatment plant operation and increasing the BOD of the treatment plant effluent.

Fish Packing Plants - There are only three fish packing plants in the Basin, all located at Newport Beach. The population equivalent of the three plants is estimated at 31,500, all discharged to the Newport Beach treatment plant with the effluent going to the Joint Outfall Sewer.

Oil Field Wastes - The major oil fields are the Seal Beach, Huntington Beach, Newport, West Newport, East Coyote, West Coyote, Richfield, and Brea-Olinda fields. There are small operators in some of these fields that discharge brines where they may pollute the subsurface water. Pollutants are still believed to be leaching from old acid sludge dumps in the vicinity of Yorba Linda and Bolsa Chica, but as far as is known there are no active acid sludge dumps in Orange County or in the Santa Ana River area at this time. (Exhibit No. 1, Appendix)

Miscellaneous - In addition to the oil fields there are 15 known industrial plants in the Basin with inorganic waste disposal problems. Among these are the Western Tank Car Company and the Portland Cement Plant at Colton, the Aluminum and Magnesium Company at Corona, the Kaiser Fontana Steel Mill at Fontana, the El Toro Marine Base at Irvine, the General Electric appliance factory at Ontario, the Revere Ware Plant at Riverside, and the Converse Rubber Company, the Culligan Zeolite Company, and the Norton Air Force Base at San Bernardino. The industrial wastes from none of these plants contain organic material that would exert biochemical oxygen demand on surface waters. Wastes from the plants contain acids or mineral salts, however, which may have a detrimental effect on subsurface waters.

Three of the 15 plants discharge wastes to tidal waters of the San Gabriel River. Wastes from one of these plants, the Los Angeles City Bureau of Water and Power Steam Plant, consist mainly of cooling water although some oil has been reported in the discharge at times.

The Dow Chemical Company plant for recovery of iodine from oil field brines was discharging wastes with a population equivalent of 27,700 and the Santa Fe Springs Waste Water Disposal Company was discharging wastes with a population equivalent of 83,500 in September 1950.[*]

Since early in the 19th century fires and overstocked ranges have accelerated erosion in the Santa Ana River Basin. Logging operations, started in the mountains around 1830, increased gradually in intensity until by 1854, San Bernardino Mormon Colony alone had five mills. Deforestation and excessive land use accentuated natural erosion processes and it is reported that disasterous floods occurred more frequently. Today, approximately 65 percent of the Basin is uncultivated and largely exposed to the ravages of fire, over-grazing and floods. The pristine balance between soil, vegetation, and precipitation has been dislocated.

Almost every drainage area in the Basin shows some effect of man-caused erosion. In some areas, streambeds have been scoured and stream bottom vegetation destroyed. Unsupported channel side slopes have gullied and slipped to rejuvinate erosion on whole mountain sides. The streams are refilling with debris, ranging from 1,400 to 9,800 cu. yd. per sq. mi. per year at and below the canyon mouths. The Corps of Engineers, Department of the Army, estimated the water and debris damages in the Basin from the 1938 flood to be $22,000,000.

Sedimentation of reservoirs and channels is a constant hazard. Government records over a period of from one to 27 years on 19 reservoirs and 19 debris basins in Southern California show average yearly rates of deposition of from 1,000 to 33,000 cu. yd. per sq. mi. The weighted average annual rate for the period of record was 4,100 cu. yd. per year.

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[*] Lower San Gabriel River Pollution Survey by State of California, Department of Public Health, Bureau of Sanitary Engineering, November, 1950.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Although the portion of the Santa Ana River having perennial flow is small compared to rivers such as the Sacramento, nevertheless, it is a significant proportion of the total length of the river in the valley. The domestic sewage from the city of Riverside is discharged to this stretch of the river and during the dryest seasons may contribute approximately one fourth of the flow. The sewage is given complete treatment including chlorination before being discharged to the stream. Recreational use of this stretch of the river has not been developed and probably will continue to be unattractive as long as it is common knowledge that a significant portion of the flow is sewage effluent. The most important water use at present is irrigated agriculture.

Odors and sulfide generation in the tidal reaches of the San Gabriel River are reported to be increasingly severe since the 1938 flood changed the profiles of the lower San Gabriel River flood control channel and the slough known as the old river channel. Complaints of odors and paint discoloration were so numerous from residents of both Long Beach and Seal Beach that the Los Angeles and Santa Ana Regional Water Pollution Control Boards in 1950 jointly requested the State Department of Public Health to make a survey of existing conditions, including an appraisal of the magnitude of the individual pollutional loads being discharged and the extent to which sludge banks might be responsible for sulfide generation.*

A maximum value of 20 p.p.m. of sulfides was found in the tidal water during the survey. The maximum surface area of septic water was found to be 57 acres during low tide and the minimum surface area 20 acres during high tide. The condition of greatest nuisance apparently occurs during warm still nights at outgoing and low tides. Paint damage is associated with humidity, and first occurs where dew has wetted lead paint surfaces.

Two cases of typhoid fever were reported in 1949 among children of families living near the Santa Ana River below Riverside. It is believed the children were infected while bathing in the Santa Ana River below the Riverside sewage treatment plant.

A classical example of a water-borne disease epidemic, occuring at Santa Ana in 1924, has been described in many engineering magazines and textbooks. A severe epidemic of dysentery affected a majority of the residents of the city of Santa Ana, population 15,500 and 238 cases of typhoid fever were reported with 14 deaths. Cases of typhoid fever traceable to the epidemic occurred as far east as Missouri and Illinois among tourists who were exposed to the disease in Santa Ana. Since a small percentage of persons who contract typhoid fever become permanent carriers of the disease, it is quite likely there are still some typhoid carriers remaining in the area as a result of the 1924 epidemic.

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*Lower San Gabriel River Pollution Survey by State of California, Department of Public Health, Bureau of Sanitary Engineering, November, 1950.

Many of the snow fed cold water tributaries to the Santa Ana River are perennial streams which are widely used as domestic and camp water supplies. Increased use of the mountainous areas for recreational purposes has increased the pollution of these streams until many of them can no longer be considered safe for domestic use without filtration and disinfection. The city of Redlands has provided a complete water treatment plant to treat water from Mill Creek, and other communities will probably have to construct treatment plants if they are to continue using surface water supplies. Information is lacking as to the quality of water furnished by many of the smaller water companies, with less than 200 service connections, but recent legislation requires that they obtain permits from the Health Department and the data are now being collected.

Polluted surface waters usually recover rapidly as soon as the source of pollution is eliminated. Ground waters are generally better protected against pollution than surface waters, but recover so slowly that when they do become grossly polluted they may take years to recover. There are areas along the coast and in the oil producing fields of Orange County where marine salt water or oil well brine intrusion has forced abandonment of water wells used for domestic water supply. Two horizons of water bearing material have been contaminated apparently with oil brine wastes, in the area north of Huntington Beach. The cities of Anaheim, Brea, Costa Mesa, Fullerton, Newport Beach, and Santa Ana are now obtaining part of their domestic water supply from the Metropolitan Water District as lowering ground water tables and the threat of salt water intrusion have curtailed the amount of water that can be obtained from local wells.

A well in the vicinity of Yorba Linda has also been polluted apparently from an acid sludge dump used by the oil industry, and a well in the northwest corner of Brea has been polluted with casing-head gasoline. Samples of water from both well and surface supplies near Brea have shown sodium ratios too high to permit use of the water on any but very open soils and boron contents too high to permit use of the water for irrigation of boron-sensitive crops. (Exhibit 2, Tables 26 and 27, Figure 3, Appendix)

There have been few cases of wells in San Bernardino and Riverside Counties having to be abandoned due to pollution, but records show significant increases in the mineral content of some well waters in recent years. Samples collected from shallow test wells downstream from the Riverside City dump show total solids four to five times and sodium ten times as great as in samples collected upstream from the dump. A well near the Exchange Lemon Products Company waste disposal field at Corona was, reportedly, damaged by underground disposal of wastes.

Dr. Robert S. Westphal, former Riverside County Health Officer, reports that many wells tested by the County Health Department which had previously given satisfactory samples have recently shown evidence of pollution. He feels there may be a possibility that cesspools and subsurface irrigation fields polluting the ground water may be responsible for the unsatisfactory samples in some instances. There are thousands of persons living in areas of the Santa Ana River Basin not served by public sewerage systems who dispose of their water-carried wastes by private cesspools or ground disposal fields. The water supply used by these suburban areas comes from thousands of private wells and hundreds of small water supply districts making adequate inspection of all water supplies impossible with present Public Health personnel.

Damage to coastal waters of the Basin has not been as extensive as at Santa Monica and other beaches in the Los Angeles Basin. Beach surveys conducted by the State Department of Public Health have, however, shown coliform counts higher than accepted beach standards in some areas, particularly near the Joint Outfall Sewer outlet at the mouth of the Santa Ana River. The condition has been so serious that closing of some beaches has been considered and the quarantine signs have actually been prepared although never erected. It would be difficult to determine to what extent the adverse publicity has affected recreational use of the beaches. (Plate 4, Appendix)

In general, there is a minimum of damage to streams and lakes caused by domestic and industrial pollutants. At the higher elevations, above 4,000 feet, in the headwaters of the mountain areas, the waters are clear and cold. These are about the only suitable trout waters of the Basin since the lower reaches of most streams do not carry a constant flow and hence they are of little or no value for fish life (Plate 4, Appendix).

The dominant factor modifying environmental conditions for aquatic life is sedimentation (Table 25, Appendix). The amount of silt varies greatly throughout the year and at times reaches extreme proportions. Natural spawning grounds and food conditions are rendered unsuitable for fish life. The scouring action of floods restricts stream development to early stages of succession. Temperature conditions are often rendered unsuitable for alpine species. This situation accentuates the problems of artificial trout stocking of catchable size fish made necessary by the extremely high fishing effort.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Although much remains to be done, many benefits are being realized from the measures already taken for abatement and prevention of pollution of the water resources of the Basin. Some of the most important benefits are reflected by improved health conditions which are intangible in that no reliable estimate can be made of the money saved by reducing the incidence of communicable diseases. In this respect it should be noted that, at treatment plants serving 28 communities in the Basin with a connected population of approximately 300,000, chlorination has been included as part of the treatment process. Chlorination of sewage effluents is ordinarily practiced only where the reduction of pathogenic organisms is considered to be of primary importance. Operation of the existing Orange County Joint Outfall Sewer as well as the other domestic sewerage systems in the Basin was of particular importance in protecting the health of thousands of armed forces personnel stationed in the area during World War II.

The existing Orange County Joint Outfall Sewer has helped protect the very valuable beaches of the Basin by collecting the sewage from much of the coastal area and discharging it, after primary treatment and chlorination, through a 3,000 ft. ocean outfall. Even though there has been some damage to beaches in the vicinity of the present outfall, the damage would have been much greater if sewage had been discharged at several points through short outfalls. Completion of the Orange County Sanitation Districts' plan including new treatment units and a longer outfall should provide additional protection to the beaches.

The existing Orange County Joint Outfall Sewer has also permitted oil fields located inland from the coast to dispose of brines to the ocean. Oil fields located near the coast generally dispose of brines to the ocean through separate waste disposal lines. Brine disposal either through the Orange County Joint Outfall Sewer or through separate disposal lines has been permitted only following adequate separation of oil from the brines. The oil thus saved has resulted in an economic benefit that probably would not have been realized if the oil field brines had been disposed of to watercourses.

Sewage reclamation was considered in the Orange County Sewage Survey, but it was concluded that under conditions present in 1947 it would be uneconomical. Further study is being given the matter by local interests, and it will be studied by the Division of Water Resources in the near future.

Pollution prevention measures in effect in the Basin have protected the quality of surface waters to such an extent that they are acceptable for agricultural uses. Value of the surface waters taken directly from streams and surface reservoirs is estimated at from 20 to 25 percent of the total water resources of the Basin or approximately $1,500,000 annually.

Pollution preventive measures have also protected the quality of the ground water resources valued at $5,500,000 annually. An increase in the boron content of the ground water to 0.5 p.p.m. might have some injurious effect on very sensitive plants and a boron content as high as 1.50 p.p.m. would make the water definitely unsuitable for a large group of boron sensitive plants including citrus fruits, avocados, and walnuts. A high total solids content or a high sodium ratio would make the water unsuitable for irrigation of any crop. An increase in the boron content of the ground waters of the Basin to the extent that citrus fruit could not be grown would result in great economic loss, and an increase in mineral constituents to the point that the ground water would be unsuitable for irrigation of all crops would be disastrous as importation of water for irrigation is difficult and expensive.

Domestic sewage treatment plants, either through use of treated effluents for irrigation or percolation of effluents to the ground water strata, make possible the reclamation of substantially all of the domestic sewage from a population of approximately 210,000 in the Basin. Only that lost to the ocean through the Orange County Joint Outfall Sewer and the Huntington Beach, Los Alamitos Naval Air Station, Sunset Beach, and Seal Beach City and Naval Net and Ammunition Depot sewerage systems is not recovered. If we assume 100 gallons of sewage per capita and a value of $10 per acre-foot for water, the value of reclaimed sewage in the Basin is approximately $235,000 annually. Actually the water thus reclaimed from sewage has a much greater value as there is no inexpensive source from which water could be obtained to replace it.

The volume of water reclaimed by irrigation or percolation of liquid industrial wastes at wineries and other industrial plants with separate sewerage systems has not been determined, but is believed to be considerable. Utilization of solid waste products from industrial plants has also been profitable in some instances. The best examples are the production of stock feed from waste orange rind and pulp at the Exchange Orange Products plant and from waste beet pulp at the Holly Sugar Company beet sugar plant.

The greatest benefit that can be attributed to pollution prevention and abatement in the Santa Ana River Basin is the protection of property values. Without satisfactory water for irrigation, agricultural land that is now valued at from $1,000 to $4,000 per acre would be used only for low value crops. Property owners have long realized that imported water for irrigation will cost considerably more than local supplies. Although the Metropolitan Water District of Southern California has some surplus water now, the project was developed as a domestic and industrial water supply and there will be no surplus when the demand from the rapidly growing communities served reaches the designed capacity. The economic future of the Basin depends directly upon the continued conservation and protection of the water resources.

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POLLUTION PREVENTION MEASURES IN EFFECT

All of the 46 sewered communities in the Basin have provided at least primary treatment for their wastes. If primary treatment followed by land disposal to sewage farms or prepared percolation beds is considered as complete treatment, 33 communities with a combined population of 215,360 have provided 31 complete treatment plants for their wastes. Ontario and Upland have constructed one plant to serve both cities and the Norton Air Force Base financed enlargement of the San Bernardino treatment plant to treat the waste from the Air Base.

Five primary treatment plants with a connected population of 121,470 serve the remaining 13 communities. Four cities, Anaheim, Fullerton, Orange, and Santa Ana, four sanitary districts, Buena Park, Garden Grove, La Habra, and Placentia; together with the U. S. Navy Lighter-than-Air Base near Santa Ana, are served by the Orange County Joint Outfall Sewer. This system comprises collecting sewers, a primary sewage treatment plant located adjacent to the Santa Ana River four miles above the mouth, and an outfall into the Pacific Ocean offshore from the mouth of Santa Ana River. The effluent from the Newport Beach primary treatment plant is also discharged to the ocean through the O.C.J.O.S. outfall. Two of the communities, Sunset Beach Sanitary District and the U. S. Navy Net and Ammunition Depot at Seal Beach discharge primary treatment plant effluent to the ocean and Bixby Ranch discharges septic tank effluent to the Santa Ana River. (Table 24, Plate 5, Appendix)

Twenty-five of the communities have provided land disposal, either sewage farms or percolation beds, in addition to other treatment, so that none of their wastes reaches surface streams. Twelve of the communities have provided ocean outfalls discharging their wastes directly to the ocean. One discharges to tidal waters at the mouth of the Santa Ana River and two discharge to tidal waters at the mouth of the San Gabriel River. The six remaining communities discharge treatment plant effluents to surface streams or watercourses at least part of the time. Complete treatment is provided for five of the six communities and the effluents are used in some cases for irrigation during the summer months. Twenty-eight of the communities have provided chlorination as part of the treatment process for their wastes, but chlorination is not continuous at some plants and the dosage used and chlorine detention provided are not adequate in many instances.

It should be noted that Colton, Corona, Hemet, and Ontario-Upland have completed and placed in operation new sewage treatment plants in 1950 and that Elsinore, Seal Beach, and the communities included in the Orange County Sanitation Districts have taken preliminary steps toward the design and financing of adequate sewage treatment works. This activity in the water pollution control field has been stimulated by two Acts, known as Chapter 47 and Chapter 20, passed by the California State Legislature to help develop a postwar construction program for needed public works.

Chapter 47, which became effective September 12, 1944, appropriated $10,000,000 for allocation to cities, counties, and cities and counties to develop a postwar public works program comprising the preparation of surveys and acquisition of rights-of-way for proposed public works and acquisition of rights-of-way and sites for major streets, roads, bridges, sewage and other public facilities. Of the money appropriated, $6,875,000 was obligated for defraying up to 50 percent of the cost of preparing plans for proposed public works and $3,000,000 was obligated for payment of up to 50 percent of the cost of acquisition by local agencies of rights-of-way and sites for construction of public works projects. Small sums were also made available for administrative costs.

Chapter 20, known as the "Construction and Employment Act" became effective May 21, 1946. The Act appropriated $90,400,000 of which $400,000 was obligated for administrative expense. Of the money appropriated, $45,000,000 was allotted to the cities in the State and apportioned to the cities in the proportion that the population of each city bears to the total population of all the cities in the State as reported by the 1940 census. The construction of sewerage facilities was given first priority by the Act and it was stipulated that application by cities for construction of other projects would not be considered unless the State Department of Public Health first certified that existing sewerage facilities were adequate to meet the reasonable needs of the city or that provision had already been made to finance construction of needed sewerage facilities. The allotments to the cities were in the form of grants made on a matching basis not to exceed 50 percent of the total cost of the project.

The Act also made $45,000,000 available to the counties of the State, one-third to be apportioned for road and bridge construction and the remaining two-thirds to be made available for construction of other projects in which there is a State interest such as hospitals, schools, sewerage facilities, roads, flood control, fire prevention and harbor improvements.

As originally written, any funds from the appropriation remaining unapportioned as of December 31, 1949, were to revert to the general fund but the law was amended by Chapter 92 which went into effect September 19, 1947, extending the time for allocation of funds to December 31, 1951, and for payment of encumbrances to December 31, 1952.

The main stem of the Santa Ana River is not a perennial stream. There is only an estimated average annual waste of from 20,000 to 30,000 acre-feet of water to the ocean representing one percent of the average annual rainfall. The normal function of a stream, to serve as a drainageway to the sea, becomes relatively less important in the case of the Santa Ana River, and the function of the stream bed as a natural spreading ground through which water and liquid wastes may enter the underground reservoirs becomes of relatively greater importance.

Federal, State, County, City and Water Company officials as well as individual water consumers have long been interested in the conservation of water supplies and management of underground reservoirs in the Santa Ana River Basin. The first authoritative investigation of the quality of underground water of the area was made in

1904 by the United States Geological Survey. In 1930 the California State Department of Public Works, Division of Water Resources, published Bulletin No. 32, a symposium of the water conservation activities and plans of Public Agencies in Los Angeles, Orange, San Bernardino and Riverside Counties.

A Report of Cooperative Work by the Bureau of Plant Industry, U. S. Department of Agriculture and the Division of Water Resources, State Department of Public Works, was published in 1933 on the investigation of quality of the irrigation waters in the South Coastal basin of California*. The investigation covers the Los Angeles and San Gabriel River basins as well as the Santa Ana and the total area under consideration is roughly double the area included in the Santa Ana River Basin. A total of 4,447 samples of water from 1,433 wells, 107 surface streams and 171 other sources including sewage were analyzed. Considered as a whole, the surface waters draining from the high mountains and the ground water from most areas in the Santa Ana River Basin were found to be of low salinity and well suited to irrigation. In certain limited areas the underground waters were found to be of intermediate to high salinity or to contain boron in concentration regarded as potentially harmful to the more sensitive plants, but the total quantity of such ground waters was relatively small.

In addition to ground waters of high salinity and high boron content, waters of high sodium, sulphate, nitrate, and chloride content were found to occur in various parts of the Basin. As a result of the survey it was estimated that 190,000 acre-feet of surface run-off of relatively low salinity from the high granitic mountains to the north percolates into the upper Santa Ana River basin annually carrying 34,000 tons of dissolved salts. The ground water travels toward the coast increasing in salinity, and although only 90,000 acre-feet of water passes from the upper Santa Ana River basin to the lower basin it carries 60,000 tons of dissolved salts. There appeared to be no accumulation of salts occurring in the pumping strata at that time, but there was evidence of salts accumulating in the subsoil at or just below the root zone and it was concluded that a total of 35,000 acre-feet of water, including sewage outflows, should be wasted to the sea from the lower basin to maintain the salt balance.

The question of salt water intrusion into the underground storage basins was also considered in the 1933 report as even then the static water level in certain sections of the coastal plain was below sea level. The total salinity and chloride content as well as the ratios of calcium to magnesium, chloride to sulphate, and chloride to boron were considered in the study in an effort to determine if salt intrusion into wells near the coast was from sea water or from deep oil wells. Not much evidence of intrusion by sea water was found at that time, but there was evidence of contamination of fresh water strata by salt water from deep oil wells. Later studies indicate marine salt water intrusion along the coast as a serious problem.

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*Bulletin No. 40, State of California, Department of Public Works, Division of Water Resources.

A great deal of work has been done on the quality of irrigation waters in the Santa Ana River Basin since 1933, but none of the agencies doing the work has published its findings. The Department of Agriculture Regional Salinity Laboratory (Rubidoux Laboratory) at Riverside is doing most of its analysis at present on samples from irrigation wells in desert areas outside the Santa Ana River Basin. It checks the boron content of the Riverside city water supply regularly and makes examinations of samples from new irrigation wells collected by the University of California Extension Service.

The State Department of Public Works, Division of Water Resources, is studying over a thousand wells in the south coastal area and has several thousand analyses recorded. These data will be tabulated and published in the near future.

Orange, Riverside, and San Bernardino Counties all have well organized Flood Control Districts authorized by law to make investigations of the quality of the ground water. San Bernardino County alone is collecting and making examination of samples collected at regular intervals from 450 wells, and has just completed construction of a new laboratory building 40' x 80' which will be devoted largely to water and soil analysis. Routine water analyses include determination of nitrates, sodium, calcium, chloride, carbonate, bicarbonates, boron, fluorides and sulphates. The results are being plotted on a large scale county map to show present concentration and changes in concentrations as compared to those published in the 1933 bulletin. The information is not yet complete enough for release, but there have been significant increases in the mineral content of some wells in localized areas.

The State and County Health Departments and the City Health Departments of the larger cities in the Basin are well organized and collect many samples of water and sewage for routine analysis in their own laboratories.

Many private water companies, industries, and private individuals collect samples of water from their own supplies and have them analyzed in private laboratories. The Babcock Laboratory at Riverside does much of this work and is one of the oldest and best known agricultural laboratories in the Southwest.

In connection with the recent changes in the State pollution control laws, the California Legislature made $50,000 available for studies of garbage and sewage disposal in 1950 and 1951. In view of the importance of ground waters in the State of California, the State University is using part of these funds as well as $16,000 made available by the State Department of Public Health from U. S. Public Health Service funds granted to the State in 1950 under Public Law 845, to study the effects of surface "contamination" and "pollution", as defined by State law, on the quality of ground waters. Specific problems to be studied are rates of percolation, depths of penetration of bacteria, and changes that take place in the chemical constituents of water and in the soil itself.

The existing Orange County Joint Outfall Sewer which serves most of the densely settled section of Orange County was started in 1921 by the cities of Santa Ana and Anaheim. It was later expanded to include two additional cities, Fullerton and Orange, and four sanitary districts, Buena Park, Garden Grove, La Habra, and Placentia. Newport Beach also disposes of its treatment plant effluent to the Joint Outfall Sewer ocean outfall.

In addition to the necessary collector and outfall sewer lines, the system includes necessary pumping stations, treatment facilities including grease removal, primary clarification, separate sludge digestion and chlorination, and an ocean outfall consisting of 3,000 feet of 42-inch diameter cast iron pipe discharging to the ocean at a water depth of 35 feet. The value of the jointly owned sewerage facility was estimated at $1,767,486 in 1946 with an additional $307,860 estimated value of trunk sewers, force mains, and pumping stations owned by individual members of the system. The present Orange County Joint Outfall Sewer system is shown on Plate 7, Appendix.

In order to establish an orderly system of sewerage development, financing, and operation, and assure adequate protection of Orange County shore waters from "pollution" or "contamination," the County Board of Supervisors on June 25, 1946, authorized a Board of Consulting Engineers* to investigate local conditions and make recommendations as to the long range plan of sewerage construction and operation to be adopted for Orange County** This plan has now been adopted by the County Board and includes the following provisions:

1. Formation of ten Sanitation Districts to cover all of the area presently deemed to require sewerage in Orange County. (Plate 7, Appendix.)

2. Joining of Districts Nos. 1-8 inclusive by contract to construct, operate, and maintain the necessary trunk sewers, interceptors, and pumping stations to convey sanitary sewage and industrial wastes from the eight districts to a treatment plant site near the mouth of the Santa Ana River.

3. Construction and operation of a sewage treatment plant to treat domestic and industrial wastes from Districts 1-8, the treatment plant to include grease removal, sedimentation, and separate sludge digestion units with design capacity of 85 M.G.D. to serve a population of 800,300 as of 1970 and 155 M.G.D. to serve a population of 1,470,200 by 1990. (Tables 28 and 29, Appendix)

4. Construction of an ocean outfall to reach an ultimate distance of 15,000 feet seaward from ordinary high water at or near the mouth of the Santa Ana River to serve Sanitation Districts 1-8 inclusive.

5. Construction of the combined system for Districts 1-8 will require a capital investment of $25,081,000 with a total annual cost estimated at $1,107,000 equivalent to an average tax rate of 15 cents per $100 assessed valuation. (Tables 30 and 31, Appendix)

6. The County Sanitation District plan of financing eliminates the need for invoking a sewer rental charge.

7. The possibility of reclaiming sewage was thoroughly investigated and found to be uneconomical as long as water is available to this area from the Colorado River.

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* A. M. Rawn, Chairman; Charles Gilman Hyde; Franklin Thomas

**Orange County Sewerage Survey, June 30, 1947

At the present time Sanitation Districts Nos. 1, 2, 3, 5, 6, 7, and 8 have been formed substantially along the boundaries outlined in the original report except that District No. 5 was divided into two districts with Newport Beach retaining the old Number 5 and Huntington Beach being given a new Number 11. District No. 4, comprising Seal Beach, Sunset Beach, and the U. S. Navy Net and Ammunition Depot, as well as parts of Barber City, Smeltzer and Wintersburg, has not been formed. It has not been decided how this area will solve its waste disposal problems as it has the possibility of joining either the Orange County or Los Angeles County Sanitation Districts or of continuing to use existing disposal facilities.

Special elections have been held and bond issues have been approved by the necessary two-thirds majority of the voters in all of the Districts set up with the exception of District No. 8, Laguna Beach. The Districts have recently, after delays caused by several legal technicalities and minor controversies, concluded the agreements of sale and purchase of those Orange County Joint Outfall Sewer facilities the Districts will acquire. It will now be necessary for the courts to pass on another legal question which may prove an impediment to the sale of the bonds. If no impediment is found to exist, it is expected that the bonds will be sold by the middle of 1951 and the work completed within three years*. However, rising costs have made it obvious that the original plan will have to be modified in certain respects in order that the available funds from the voted bond issues will be adequate to complete the project. The Districts have now hired a General Manager, an Engineer, and a Secretary as a full time staff and have retained an Attorney to draft the necessary legal documents.

Most of the industries and industrial waste disposal problems in the Basin are grouped around the Colton, Fontana, Cucamonga, Ontario area of San Bernardino County, and the Santa Ana, Orange, Anaheim, Fullerton area in Orange County. Although State and local agencies have much general information on the pollution preventive measures that have been placed in effect by industries, there is not enough factual data on the design capacities and population equivalents to give the complete picture. The locations of known industrial waste treatment facilities are shown on Plate 6, Appendix, and the available information is shown on Keys to the Plate.

Nearly all of the wineries in the area are members of the Wine Institute which conducts experiments on winery waste disposal problems and makes information on disposal methods available to members of the Institute. In the ordinary dry wineries, of which there are known to be approximately 32 in the area, the liquid wastes are usually disposed of by irrigation, and the pomace or pulp is spread on the vineyards as fertilizer or mulch. The distilleries which make brandy and sweet wine in addition to dry wine, of which there are 19 in the area, have a much greater problem in disposal of still slops. Usually the still slops are kept separated from other wastes and lagooned.

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* Subsequent to preparation of this report, the courts passed upon questions of legality of sale of bonds and ruled that no impediments have been found to exist.

Of the 48 known fruit and vegetable processing plants in the Basin, 24 are in Orange County and are now connected to the Orange County Joint Outfall Sewer. Those not now connected to the Joint Outfall have been covered in the Orange County sewage survey and are included in the Orange County Sanitation Districts to be served by the new Orange County Sanitation Districts sewerage system. The Orange County industries are concentrated in Sanitation Districts 1, 2, and 3. The yearly average B.O.D. from industries in Districts 1 to 8 is almost twice that of the domestic sewage and the peak monthly average is almost four times the domestic B.O.D. (Table 32, Appendix). Several of the industries not connected to the Orange County Joint Outfall Sewer have provided waste treatment facilities, part of which may be utilized for pretreatment of wastes after the Orange County Sanitation Districts sewerage system is completed. One of the best examples of these is the Holly Sugar Company beet sugar plant near Santa Ana which has provided fine screens, chemical flocculation, aeration, sedimentation, and broad irrigation for wastes with a population equivalent B.O.D. of 120,000.

Many of the 24 known food processing plants in Riverside and San Bernardino Counties have provided waste treatment or utilization facilities. The Exchange Orange Products plant at Ontario processes the citrus peel and pulp left after juice extraction into stock feed. The company has also purchased 240 acres of land in an isolated area for liquid waste disposal and constructed a tile line several miles from the plant to the disposal area. The Exchange Lemon Products plant at Corona has also provided land disposal for liquid wastes with a long tile line to carry the wastes from the plant to the disposal area.

The Pliny Cross slaughterhouse, Sieck slaughterhouse, Fontana Farms Company, Swift Duckling Farm, Loma Linda Food plant, and Hemet Packing Company dispose of liquid wastes either to percolation beds or to irrigate crops.

Since there are no flowing streams in much of the area where industries are located, pollution of surface waters is much less of a problem than the possible effect of waste discharges on ground waters. In this respect industries with inorganic waste are probably of more importance than those with organic wastes. There are 20 known plants with inorganic waste disposal problems in the Basin. State and local agencies are quite concerned with and spend considerable time in reviewing existing and proposed waste discharges and treatment facilities utilized by the plants and in investigating the effect that percolation of these wastes into the soil is having on the underground water.

Included in the 20 plants are the eight* major oil fields, all located, wholly or in part, in Orange County. In general, those fields near the coast dispose of brines to the ocean after oil separation. Those further inland dispose of brines to the Orange County

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* Listed as five plants in Exhibit 1 and key to Plate 7 for reasons therein explained.

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Joint Outfall Sewer or through the Santa Fe Waste Water Disposal Company system. There are still some small operators disposing of brines in a manner which may permit pollution of ground water sources. The County of Orange enforces its own industrial waste ordinances and employs a consulting engineer for water pollution studies. A report by Mr. Fred Dierker, Jr., Assistant Sanitary Engineer, State Department of Public Health, entitled "Data on Oil Fields in the Santa Ana River Basin" and a progress report by Mr. Loren E. Blakeley, Consulting Civil Engineer, on the Brea Canyon investigation are included in the Appendix. (Exhibits 1 and 2)

Three of the plants in the area are hauling wastes out of the Santa Ana River drainage area for disposal in order to eliminate the possibility of damaging the ground water supply. These plants are Aluminum and Magnesium, Inc. near Corona which is hauling slag to Amboy in the Salton Sea Region for disposal in a desert area where the ground water is already saline; the General Electric Corporation factory at Ontario which hauls chromic acid wastes to Anaheim for disposal to the sea through the Orange County Joint Outfall Sewer; and the Hunter Douglas Co. at Riverside which disposes of high fluorine, chromium and arsenic wastes to the sea through the Los Angeles Hyperion sewer system.

The Western Tank Car Company at Colton has provided very complete treatment facilities for wastes from cleaning and repairing tank cars. High sodium wastes are evaporated so that no sodium enters the soil. All liquid wastes pass through an oil separator and all acid wastes are neutralized before disposal to percolation beds. The Revere Ware plant at Riverside and the Norton Air Force Base at San Bernardino also neutralize all acid wastes.

Water used to leach soluble salts from manufactured zeolite at the Culligan Zeolite Co. plant near San Bernardino is disposed of to percolation sumps. The high salinity and high concentration of sodium in the wastes has long been thought to be a threat to the quality of the underground water. Considerable study has been made of this disposal by the State Department of Public Health as well as the County Flood Control District and the County Health Department. Many samples of water collected from wells two miles from the point of waste discharge have shown no conclusive evidence of damage to the underground water.

Treatment units were provided for industrial wastes at El Toro Marine Base, but the plant has apparently never been operated.

In the Santa Ana River Basin there are extensive agricultural, industrial, and residential areas built on the valley floors close to precipitous mountains. The mountains, because of their particular geologic history, are subject to natural erosion and require preservative measures (Table 25, Appendix.) The need for such constructive measures is emphasized by the intense land use that accompanies a rapidly expanding agricultural economy which accentuates the erosion problem. Highly productive and thickly populated areas are exposed to flash flood flows from the canyon mouths that constitute a serious flood hazard. According to the U. S. Geological Survey (Water Supply Paper 884, 1942), a severe storm in March 1938, caused flood damage amounting to approximately $80,000,000 in Southern California and $14,000,000 in the Santa Ana River Basin.

To reduce flood damage in the hazardous mountain sections of the Basin, channels and levees have been built to check the flood waters temporarily and carry them off under control. Canyon silt and debris are removed at a high cost. Efforts to control the erosion at its source are also being made by Federal and State agencies. Planting to establish or improve the vegetative cover for erosion control has been carried out during the past 40 years by the U. S. Forest Service and the local agencies. Studies are being made of the best ways to prevent erosion of road slopes, landslip scars, burned areas, gullied meadows, stream channels and sparsely vegetated areas.

In addition, erosion problems of the farms in the Basin are being studied by the U. S. Soil Conservation Service in cooperation with State agencies. This program includes construction or repair of dams, dugouts and stock ponds to hoard rainfall on the ground surface; drilling of wells, improvement of springs, and the installation of pumps to recover underground water supplies; and also the discovery and application of improved methods of soil cultivation aimed toward the conservation of water.

The following seven Soil Conservation Districts are located in whole or in part within the Santa Ana River Basin. (Plate 1, Appendix)

Name of District	Field Office Location
North Orange County	Fullerton
Yucaipa Valley	Redlands
San Gorgonio	Beaumont
San Jacinto	Hemet
Elsinore-Murrieta-Anza	Elsinore
Redlands Highland	Redlands
Mira Loma	Ontario

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Because of comprehensive changes in legislation on water pollution control enacted by the California Legislature at its 1949 regular session, current procedures for prevention of water pollution differ drastically from those previously in effect. Prior to December 15, 1949, the effective date of the new legislation, the State Department of Public Health had primary responsibility, through provisions of the Health and Safety Code, for control of water pollution by means of a permit system. The Division of Fish and Game, the Division of Water Resources and other State and local governmental units also had an interest in and responsibilities for certain phases of water pollution problems.

The 1949 legislation was enacted following a two-year study conducted by a legislative Interim Fact-Finding Committee on Water Pollution. The recommendations of the Committee were used to draft a series of eleven bills which were revised and finally enacted in the 1949 legislative session.

The following summary of the new legislation was prepared by the Committee and indicates the scope and intent of this enactment:

"The existing permit law, which in theory requires that all disposals of sewage or industrial waste be controlled under permit issued by the State Department of Public Health, is repealed on December 15, 1949 (Chapter 1550). By this action the health officials are enabled to concentrate their effort upon those conditions which

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are, or threaten to become, actual hazards to the public health. The term 'contamination' is defined to mean ' . . . ' State and local health officers both are empowered to issue peremptory orders for abatement of conditions of contamination, and any person failing to correct such a condition may be guilty of a misdemeanor.

"Various sections are added to the Health and Safety Code to strengthen the powers of the State and local health officers in control of individual sewage disposal, and the act also provides for adequate supervision and control of the hundreds of so-called small water systems which were unregulated under previous law.

"Control of the economic effects of sewage and industrial waste is established by the Dickey Water Pollution Act (Chapter 1549). The terms 'pollution' and 'nuisance' are defined in the act to mean the adverse and unreasonable effects of disposal of sewage or industrial waste which are not actual hazards to health. Pollution and nuisance are subject to control by Regional Water Pollution Control Boards which are created for the nine major drainage regions of the State. The regional boards are composed of five appointees representative of the major interests involved. They have the duty to coordinate the action of the numerous governmental agencies involved and to promote cooperative action with waste producing industries. The boards are empowered to make and enforce rulings as to conditions to be maintained in all instances of pollution and nuisance, existing or threatened, within their region, but the boards may not specify the manner or means of maintaining the required conditions. Communities within a region are not prevented from adopting and enforcing additional regulations which may be deemed necessary. Upon failure of anyone to comply with an order of a regional board, an action for injunctive relief must be brought by the district attorney, or, if he should fail to act, by the Attorney General.

"A State Water Pollution Control Board is created, consisting of the State Engineer, the Directors of the Departments of Public Health, Agriculture and Natural Resources, and nine appointees representative of the regions of the State and of the various interests in these problems. The state board has the duty to undertake statewide planning for pollution control, acting in an advisory capacity to the regional boards. It will direct research programs in the technical phases of pollution control, and will administer the State Water Pollution Control Fund. The state board may act as an appeal board in any specific instance of pollution where it is found that a regional board has not taken proper action.

"An executive officer and staff is provided for each of the boards. Funds for administrative expenses are appropriated to the state board for allocation to the regional boards (Chapter 1554). The state and regional boards may obtain assistance from any state or local agency, and the state agencies most concerned with pollution problems--the Department of Public Health, the Division of Fish and Game and the Division of Water Resources are specifically directed to cooperate with and assist the control boards (Chapters 1549, 1550, 1552 and 1553).

"Financial assistance to communities for sewerage projects is provided by means of loans from a State Water Pollution Control Fund (Chapter 1551). This fund will be administered by the State Water

Pollution Control Board. All or any portion of funds needed for a sewerage project may be loaned, with payments deferred as long as may be considered necessary, upon security of bonds of the community. Before state funds are loaned it must be shown that the project is feasible and cannot be financed through private sources. Cities and districts are allowed to issue 'second mortgage' revenue bonds to secure such loans, or to secure similar loans which may be available from the Federal Government or from any other source (Chapter 1555). Communities can enter into long term contracts with industry for waste disposal (Chapter 1555), and an appeal procedure for review of sewer rental charges is established (Chapter 865). Funds necessary for sewerage facilities are excluded from tax limitation in cities of the sixth class (Chapter 1253).

"The Division of Water Resources is directed to conduct a continuing survey of water quality in the State with regard to pollution from all sources (Chapter 1552). The division is directed to study all facts relating to the feasibility of reclamation of waste-water for industrial or agricultural purposes. Water-well drilling practices, as they relate to pollution of underground waters, will be investigated, and the division will recommend minimum standards for proper well construction and sealing of abandoned wells in particular areas. Reports and recommendations relating to these matters are to be made by the division to the Legislature and to the appropriate Regional Water Pollution Control Board. Every person who hereafter constructs or alters any water-well must file a detailed report with the appropriate regional board, Failure to do so, or falsification of such record, is a misdemeanor. Violation by any licensed well driller of any provision of the Health and Safety Code or Water Code relating to water-well drilling is made grounds for disciplinary action by the State Contractors' License Board (Chapter 1433). The University of California is allocated $50,000 for research in technical problems of disposal of sewage, garbage and industrial waste. (Chapter 1575)

"Continuation of the Water Pollution Committee for a second interim period (House Resolution 250) makes possible a detailed factual study of the operation of these new laws as they will be applied to the thousands of pollution problems which exist throughout the State. The scope of the committee's investigation is extended to include the other important problems of water quality which arise from agricultural use, saline intrusion, and all other sources and causes of quality impairment. In addition the committee is specifically directed to investigate the problems involved in the reclamation and reuse of waste waters, particularly in the Santa Clara Valley, (House Resolution 198), and the related state-wide problems of air pollution resulting from industrial wastes and other causes (House Resolution 284)."

The following statement concerning the ACTIVITIES OF THE DIVISION OF WATER RESOURCES IN WATER POLLUTION CONTROL UNDER CHAPTER 1552, STATUTES OF 1949 was furnished by Mr. A. D. Edmonston, State Engineer, Chief of the Division:

"Chapter 1552, Statutes of 1949, added Sections 229, 230, and 231 to the Water Code. This provides the statutory authority for investigations in the field of water pollution by the Division of

Water Resources. The Department of Public Works, hereinafter called the department, acts by and through the State Engineer who is Chief of the Division of Water Resources.

"Section 229 The department either independently or in cooperation with any person or any county, State, Federal or other agency, to the extent that funds are allocated therefor, shall investigate conditions of the quality of all waters within the State, including saline waters, coastal and inland, as related to all sources of pollution of whatever nature and shall report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters.

"Section 230 The department, either independently or in cooperation with any person or any county, State, Federal or other agency, to the extent funds are allocated therefor, shall conduct surveys and investigations relating to the reclamation of water from sewage or industrial wastes for beneficial purposes, including but not limited to the determination of quantities of such water presently wasted, and possibilities of use of such water for recharge of underground storage or for agricultural or indutrial uses; and shall report to the appropriate regional water pollution control board thereon, annually.

"Section 231 The department either independently or in cooperation with any person or any county, State, Federal or other agency, shall investigate and survey conditions of damage to quality of underground waters, which conditions are or may be caused by improperly constructed, abandoned or defective wells through the interconnection of strata or the introduction of surface waters into underground waters. The department shall report to the appropriate regional water pollution control board its recommendations for minimum standards of well construction in any particular locality in which it deems regulation necessary to protection of quality of underground water, and shall report to the Legislature from time to time, its recommendations for proper sealing of abandoned wells.

"In the Santa Ana River Basin, a program of periodic sampling to determine chemical, physical and bacterial characteristics of the major streams at points of inflow from the mountains and of outflow from the ground water basins, has been instituted. Periodic sampling of ground waters from representative wells in each ground water basin will be started in the near future. Sea-water intrusion along the Coast is being studied in cooperation with the U. S. Geological Survey.

"A study of oil industrial wastes and the disposal thereof in Orange County has been undertaken at the request of the Regional Water Pollution Control Board.

"An investigation of the quality of ground waters in the Upper Santa Ana Valley and of maintenance of salt balance in ground water basins will be started this year (1951). The damage to quality of ground waters due to abandoned, improperly constructed and defective wells in Orange County will be studied and minimum standards for well construction set up. Further necessary investigations will be started as fast as funds and personnel available permit."

*It will be noted in the above summary of the California water pollution control legislation, now in effect more than a year, that

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*The remaining portion of the section on Water Pollution Control Measures in Effect describing special studies being conducted by the Santa Ana Regional Water Pollution Control Board was prepared by Mr. Paul G. Brown, Executive Officer of the Board.

there are two distinct avenues for acquisition of data on the effects of pollution. One, the broad and continuing studies of the Division of Water Resources, has already been described. The other gives the Regional Boards authority to request specific technical studies and investigations from other State and county agencies equipped to do fact-finding work.

In practice, this latter avenue has proven very successful in seeking out factors related to specific pollution problems which present the Boards with the necessity for immediate action toward their solution. It also provides a separation between fact-finding and regulation, which, it is believed, will result in the most equitable administration of pollution control. Specifically, the staff of the Santa Ana Regional Board, since its employment in May 1950, has done practically no investigative work except in a general or preliminary manner. The staff includes but one engineer, who is also the Executive Officer and whose time is largely devoted to administration. However, the extensive investigations described below have already been undertaken at the Board's request and are carried out in close consultation with the Executive Officer.

The early success of this program has been largely due to an excellent plan of coordination worked out among the various State Departments concerned. The Department of Finance allotted sufficient funds to the Bureau of Sanitary Engineering and to the Division of Water Resources from 1950-51 fiscal year appropriations to carry this load without curtailment of other duties. These three agencies, together with the Fish and Game Commission, decided on a program which delineated each group's field of interest in pollution control and which set up an unofficial coordinating committee to screen requests for technical assistance from the Regional Boards. This committee's function is to assure that a particular study is done by the agency best equipped to do it or into whose natural field of interest it falls. In this manner overlapping of work is held to a minimum, results are expedited, and exchange of information is promoted.

There are nearly 3,000 producing oil wells in the Santa Ana River Basin, concentrated into eight fields in Orange County. Latest available figures indicate that in these fields approximately 4.84 million gallons per day (approximately 5,400 acre feet per year) of connate water is brought up with the oil. A very large percentage of this water is known to be very saline and completely unsuitable for domestic or agricultural use. Since the ocean is relatively near all of these fields, it is the practice to dispose of nearly all of these waste waters into it either through the Joint Outfall Sewer, through the system of the Santa Fe Springs Waste Water Disposal Company, or in the beach fields, into tidewater through small collection systems or individual lines.

However, it is known that there are a number of instances where oil producers have not found it convenient or possible to employ ocean disposal for waste water and have practiced land disposal. These practices have been most notable in the Richfield, East Coyote and Huntington Beach fields. Lack of additional capacity in the Joint Outfall Sewer system has added to the difficulty of providing ocean disposal for brines from the first two of these fields.

It was obvious to the Regional Board, that, pending completion of the Joint Outfall Sewer system enlargement and the provision of county-wide sewerage through the Sanitation Districts plan, a survey should be instituted to determine if present oil field waste disposal practices are likely to be seriously detrimental to ground water supplies in or near the fields. In the summer of 1950 the Board accordingly requested from the Division of Water Resources a full scale survey and report on all oil industry waste disposal practices in Orange County with relation to possible pollution of ground water.

This study was begun immediately and is still in progress, thus indicating the magnitude of the problem. The scope of the study is shown by the following Outline of Investigation being followed by the Division in each of the seven ground water basins of the County:

"Secure and analyze all available data. Supplement this by field survey where necessary covering the following subjects:

"(1) Oil well development and historic data on disposal of wastes, to include preparation of a base map showing oil field limits and sub-divisions and separate maps of each oil field to show existing and abandoned disposal areas.

"(2) Quantity and quality of oil industry wastes and current disposal methods from all fields overlying or tributary to water supplies in Orange County.

"(3) Locations of all existing and abandoned oil and gasoline lines.

"(4) Geology of report area, to include geologic map of entire area and geologic sections for each oil field.

"(5) Hydrology-pertinent data on stream flow in main streams and ground water levels for 1936, 1941 and 1950. This information to be prepared in the form of ground water contour maps."

Progress reports to the Board indicate that approximately 16% or 102,000 gallons per day (114 acre-feet per year) of waste water in the Richfield and East Coyote fields is being disposed of in sumps and cesspools. It is expected that enough chemical, hydrological, geological, and waste quantity data will soon be reported to give the Regional Board a firm basis by which to assess the problem and to take corrective action, if warranted, in these fields.

Another study undertaken in 1950 by the Bureau of Sanitary Engineering at the joint request of the Santa Ana and Los Angeles Regional Boards was that of pollution of the tidal prism of the San Gabriel River and has already been described. This study cleared up many questions which were hindering a rational approach toward solution of the problem. With sufficient factual data in their possession, the two Boards have developed a continuing program of abatement of the condition and a possible upgrading of water uses in this potential recreational area.

A waste discharge in existence for several years at the Culligan Zeolite Company has been the cause for considerable concern among official agencies and water users in the area. Water used to leach soluble salts from manufactured zeolite is disposed of in percolation sumps. This waste is chiefly sodium carbonate and has been found in the sumps to contain a total salinity of 10,000 p.p.m. Since the extremely high sodium percentage, as well as high salinity, has been thought to be a threat to the underground water, considerable study has been made of this disposal by the State Department of Public Health and the San Bernardino County Flood Control District and Health Department. However, repeated checks of wells two miles distant from the beds have indicated no change ascribable to the waste. Since no closer downstream wells are available and since damage may be quite severe when producing wells are finally affected, it was agreed by all concerned, including the Company, that construction of test wells on or near the property is advisable.

The Regional Board accordingly requested the Division of Water Resources to make a complete study of the problem, including the drilling of test wells. This work, in cooperation with the San Bernardino County authorities, is expected to begin shortly. Little information exists on ground water conditions in this area and this study is expected to provide needed hydrological data as well as to settle the question of damage resulting from waste disposal.

Two other major studies, in addition to several lesser investigations, have been made by the Bureau of Sanitary Engineering at the request of the Regional Board. One concerned the disposal of phenolic and chromium bearing waste from the Pacific Airmotive Airport near Chino, and was made jointly by the Bureau and the San Bernardino Flood Control District. Percolation tests through native soil revealed two facts of considerable interest to pollution control in Southern California: (1) A large percentage of the phenolic compounds at this concentration (approximately 200 p.p.m.) pass through a six foot soil column unchanged and (2) soluble hexavalent chromium removed from aircraft skins by phenolic strippers is almost all removed from the wastes in the same soil column. The results of this study have just become available to the Regional Board, and action toward correction of the problem will be taken on the basis of the facts obtained thereby.

The second study, a report of which is now under preparation, had for its purpose the determination of the extent of pollution and nuisance at the beaches near the Orange County Joint Outfall disposal area under winter conditions when chlorination is discontinued. Repeated odor complaints have been received from nearby residents but the source of the odors has not been certain. It is expected that this study will clear up this question and provide the Regional Board with a better picture of its responsibility in this matter.

POLLUTION PREVENTION MEASURES REQUIRED

Public Law 845, the Federal Water Pollution Control Act, and California legislation, Chapter 1549, relating to water pollution, contain somewhat divergent provisions insofar as the delineation of pollution prevention measures required is concerned. Briefly the pertinent sections of the State and the Federal legislation and the interpretations that have been given to each by certain State authorities and by the P.H.S. respectively are as follows:

California Legislation

Section 13053 - "Each regional board shall prescribe requirements relative to any particular condition of pollution or nuisance, existing or threatened, in the region.

Section 13054 - "Any person proposing to discharge sewage or industrial waste within any region, other than into a community sewer system, shall file with the regional board of that region a report of such proposed discharge. The regional board, after any necessary hearing, shall prescribe requirements as to the nature of such discharge with relation to the conditions existing from time to time in the disposal area or receiving waters upon or into which the discharge is proposed and notify the person proposing the discharge of its action. Such requirements may be revised from time to time. After receipt of such notice, the person so notified shall provide adequate facilities to meet any such requirements with respect to the discharge of sewage and industrial waste.

Section 13064 - "No order issued under the provisions of this article shall specify the design, type of construction or particular manner in which an operation causing or threatening to cause a condition of pollution or nuisance is to be corrected, and the person so ordered shall be permitted to correct the condition in any lawful manner.

Section 13022 - "The state board shall formulate a state-wide policy for control of water pollution with due regard for the authority of the regional boards."

On the basis of these provisions it has been pointed out that it is not permissible for State authorities to pass upon the adequacy or inadequacy of existing sewerage systems and treatment and disposal facilities in advance of study of technical factors involved and any necessary hearings. Furthermore, State authorities may not specify type of sewage treatment facilities which should be provided.

Federal Legislation

Section 2 (a) P.L. 845 - "The Surgeon General shall, after careful investigation, and in cooperation with other Federal agencies, with State water pollution agencies and interstate agencies, and with the municipalities and industries involved, prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. In the development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural, industrial, and other legitimate uses. For the purpose of this subsection the Surgeon General is authorized to make joint investigations with any such agencies of the condition of any waters in any State or States, and of the discharges of any sewage, industrial wastes, or substance which may deleteriously affect such waters.

Section 5 - "The Federal Works Administrator* is authorized, subject to the provisions of section 9(c), to make loans to any State, municipality, or interstate agency for the construction of necessary treatment works to prevent the discharge by such State or municipality of untreated or inadequately treated sewage or other waste into interstate waters or into a tributary of such waters, and for the preparation (either by its engineering staff or by practicing engineers employed for that purpose) of engineering reports, plans, and specifications in connection therewith. Such loans shall be subject, however, to the following limitations: (a) No loan shall be made for any project unless such project shall have been approved by the appropriate State water pollution agency or agencies and by the Surgeon General, and unless such project is included in a comprehensive program developed pursuant to this Act;"

On the basis of these provisions it has been reasoned that a comprehensive program must be aimed at bringing all water within the area covered by the program to a condition acceptable for the uses to which the waters are to be put. Further, that the means by which this is accomplished should include provisions for treatment works as a means of eliminating or reducing pollution and the program should be in sufficient detail so that particular treatment works may be said to be included in the program.

In view of these circumstances the statement of community waste treatment needs in this report has been developed to satisfy both viewpoints by presentation of the following three Tables - A, B, and C.

Those communities listed in Table A that have in process some specific action for improvement of waste treatment plants should proceed with the actual construction. Probably the most urgent of these projects is the completion of portions of the Orange County Sanitation Districts' program as planned or modified by circumstances arising subsequent to preparation of the plan.

The waste treatment problems of communities listed in Table B are believed to be less serious than those in Table A, and additional studies will be required before the nature of improvements needed can be determined.

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*The Federal Works Administrator's authority contained in Section 5 of P.L. 845, 80th Congress was transferred to the Federal Security Agency Administrator under the Reorganization Plan No. 16 of 1950.

TABLE A

Communities that have recognized the need for improved waste treatment facilities and have in process some specific action for the provision of new treatment works or the alteration or extension of existing works; in some cases Regional Board requirements may already have been prescribed for the action; in other cases such requirements will presumably be prescribed as the particular community's action program progresses:

Community	Type of Works	Status
Orange County Sanitation Districts 1, 2, 3, 5, 6, 7 and 11	Enlargement of treatment facilities; longer ocean outfall	Bonds voted; plans under preparation
Costa Mesa Sanitary District	Provision of local sewers	Bonds voted; plans approved
Midway City Sanitary District	Provision of local sewers	District formed; plans approved
City of Brea	Enlargement of treatment facilities	Plans accepted
City of Seal Beach	Enlargement of treatment facilities	Plans accepted; bond election set
City of Fullerton	Enlargement of treatment facilities; longer ocean outfall	Included in Sanitation Districts above
City of Huntington Beach	"	"
City of Newport Beach	"	"
City of Orange	"	"
City of Anaheim	"	"
City of Santa Ana	"	"
Buena Park Sanitary District	"	"
Garden Grove Sanitary District	"	"
La Habra Sanitary District	"	"
Placentia Sanitary District	"	"
City of Elsinore	Improvements to treatment facilities	Contract let
La Sierra College	Improvements to treatment facilities	Plans under preparation

TABLE B

Communities that, on the basis of presently available information, may need new or improved waste treatment facilities; the actual nature of improvements to be determined by the communities at such time as the problem becomes critical and requirements have been prescribed by the Regional Board. (Plate 8, Appendix)

- Bixby Ranch
- Redlands
- Rialto
- San Jacinto
- Sunset Beach Sanitary District

TABLE C

Communities that have neither public sewer systems nor sewage treatment works but may need such facilities in the not too distant future: (Plate 8, Appendix)

Orange County	Riverside County	San Bernardino County
Barber City	Alberhill	Bloomington
Cypress	Edgemont	Crestmore
El Modena	Glen Avon	Cucamonga
Los Alamitos	Grand Ave., Elsinore	East San Bernardino
Olive	Highgrove	Etiwanda
Stanton	Home Gardens	Fontana
Tustin	La Sierra Heights	Grand Terrace
Villa Park	Mira Loma	Highland
Westminister	Moreno	Los Seranos
Wintersburg	Norco	Mentone
Yorba Linda	Pedley	North Loma Linda
	Romoland	Yucaipa
	Sedco	
	Sunnymead	
	University Heights	
	West Riverside	

Many of the communities listed in Table C are unincorporated fringe areas where satisfactory disposal of domestic wastes by private subsurface disposal fields is becoming more and more of a problem. Long range plans should be made for solving these problems, possibly through construction of sewage collection and treatment systems on a wider basis than the usual single community system.

Presently available information on industrial waste problems is inadequate to permit completion of tables for industries similar to those prepared for communities. Most of the industrial waste disposal problems in Orange County will be solved by construction of the Orange County Sanitation Districts system to collect unreclaimable industrial wastes for disposal to the ocean.

The Division of Water Resources explains the fundamental problem of industrial waste disposal in the San Bernardino and Riverside County portions of the Santa Ana River Basin as follows:

"In the system of ground water basins which make up the Santa Ana River Basin, the ground water flows successively from higher to lower basins, either as underflow or rising water until it finally reaches the coastal plain of Orange County. The water table there is either below or little above sea level for so much of the time that outflow of ground water is negligible. Thus pollutants entering the ground water of the highest basin in San Bernardino County, if not altered en route, eventually reach the coastal plain of Orange County. So long as pollution in any basin in San Bernardino and Riverside counties continues and no provision is made for its removal after it reaches Orange County, the concentration of the pollutant in the ground water there will increase without limit. The formulation of plans for the disposal of industrial wastes originating in San Bernardino and Riverside counties and action on such plans before wide scale industrialization takes place is of major importance."*

Since construction of an industrial waste sewer system to collect unreclainable wastes from the industrial areas of the upper Santa Ana River valley and discharge them to the ocean appears to be the logical solution to the problem, the possibility of building additional capacity into the Orange County Sanitation Districts system should be investigated as the cost should be less than for a separate parallel line across Orange County.

There is also a need for more comprehensive training and supervision of treatment plant operators in order to assure a maximum return for the investment in waste treatment facilities in the Basin. Such training should be slanted toward giving the operators a better understanding of the basic physical, biological, and chemical factors involved in the various treatment processes as well as practical training in maintenance of equipment.

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*From private correspondence.

APPENDIX TO SANTA ANA
RIVER BASIN REPORT

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Table 1

Areal Distribution
In the Santa Ana River Basin of California

Counties	Area of Co. Sq. Mi.	Area of Co. In Basin Sq. Mi.	Percent of Co. in Basin	Percent of Basin Represented By Co.
Riverside	7,223	1,230	17.0	44.2
San Bernardino	20,157	1,000	5.0	35.9
Orange	795	554	69.7	19.9
Totals		2,784		100.0

Table 2

Stream Data for the Santa Ana River and Various Tributaries, California
(Data from the Corps of Engineers, U.S. Army)

Stream	Length	Approximate Drainage Area	Average Slope	
			Mountains	Valley
	Miles	Square miles	Feet per mile	Feet per mile
Santa Ana River	100.0	2,470.0	240	26
Tributaries (in downstream order)				
Bear Creek	7.7	83.0	430	(*)
Mill Creek	16.6	47.0	410	175
Plunge Creek	12.0	25.0	520	80
Oak Creek	3.5	2.4	715	120
Elder Creek (or Gulch) . . .	3.0	1.6	780	120
City Creek (via bypass) . . .	14.0	**19.9	520	50
Zanja Creek	14.0	33.3		80
San Timoteo Creek	20.6	130.0	80	60
Noble Creek	10.5	8.4	600	120
Little San Gorgonio Creek. .	10.0	8.0	500	140
Singleton Creek	6.0	7.2	400	135
Yucaipa Creek	14.0	51.3	105	(*)
Warm Creek	8.5	235.0		30
Sand Creek	5.3	5.0	525	160
East Twin Creek	9.0	14.0	705	85
Strawberry Creek		8.6		
Waterman Creek	5.0	5.2	665	70
Devil Creek	12.5	17.0	900	70
Lytle Creek		161.0	440	55
Cajon Creek	23.0	95.0	150	100
Cable Creek	7.0	15.0	1,100	100
San Sevaine Creek	6.0	5.0	830	80
East Etiwanda Creek	14.0	12.0	800	90
Day Creek	20.0	16.0	1,000	90
Deer Creek#	19.0	9.0	1,400	100
Cucamonga Creek	21.0	38.5	800	60
Temescal Creek	26.5	##251.0		28
San Jacinto River	62.0	767.0	430	23
North Fork	10.0		660	(*)
Bautista Creek	18.5	58.0	300	90
San Antonion-Chino Creek . . .	31.0	124.0	400	55
Santiago Creek	29.5	91.0	125	35

* All in mountains.

** All flow in excess of 250 c.f.s. is bypassed to Santa Ana River at a point between Redlands and San Bernardino. Natural channel is tributary to Warm Creek.

# Deer Creek normally is tributary to a small stream flowing into Prado flood-control basin but, because of an unstable channel, may flow to the right or left across the alluvial cone and enter Day Creek or Cucamonga Creek.

## Excludes drainage area of San Jacinto River (767 sq. mi.)

Table 3

Characteristics of Watershed Soil Groups in the Santa Ana River Basin of California 1/
(Table Provided by the U. S. Forest Service)

Soil Group	Geologic Formation	Soil Age	Percent of Total Mountain Area	Soil Depth		Water Storage 4/			Permeability	Erodibility	Substratum	
				Average	Range	WP 2/	WP to FC	FC to Sat. 3/			Permeability	Porosity
				Feet		Inches						
San Gabriel	San Gabriel formation, metamorphic complex	Recent	2.9	3	0-8	1.2	1.5	12.4	High	High when exposed	Moderate	Low to moderate
Boquet	Pelona schist	Recent	6.2	2	1-3	1.2	1.2	3.2	High	Low	Low to moderate	Low to moderate
Wilson	Acidic intrusives, diorite, lowe granodiorite, monzonite											
Crustal	Landslides and fanglomerates--unconsolidated	Recent	0.3	½	0-1	.3	.6	1.6	High	High when exposed	Very high	Very high
River-wash	Riverbed, flood plain, recent alluvium	Recent	7.8	--	--	.4	.5	4.0	High(infiltration rate low if water table high)	Low	Very high	Very high
Terrace	Quarternary terraces (unconsolidated and gravelly)	Immat.	8.2	4	3-6	7	7	6.5	Medium to low	High when exposed	Very high	Very high

Table 3 - Continued

Soil Group	Geologic Formation	Soil Age	Percent Of Total Mountain Area	Soil Depth		Water Storage 4/			Permea- bility	Erodi- bility	Substratum	
				Aver- age	Range	WP 2/	WP to FC	FC 3/ to Sat.			Permea- bility	Porosity
				Feet		Inches						
Castaic	Poorly consolidated sediments, mostly sandstones	Recent	1.2	1	0-2	.6	1.2	3.2	High	Moderate	Very high	Very high
Violin	Consolidated conglomerates, sandstones, shales	Recent	1.3	2	1-3	3.4	3.4	1.6	Moderate	Moderate	Moderate to high	Moderate to high
Frigid	Cajon sediments (consolidated sandstone)	Immat.	3.4	3	2-6	4.0	4.6	6.4	Medium (subsoil low)	High	Low	High
Compromise	Igneous and metamorphis basement complex, well mixed	Recent	32.8	1	0-3	.6	1.2	3.2	High	High	Low	Low
Baldwin	Saragossa quartsite, Arrastre quartsite	Immat.	4.5	3	2-5	4.0	4.6	6.4	High	High when exposed		
Furnace	Furnace limestone	Young	2.9	2	0-5	1.2	2.4	6.4		Moderate	Moderate	Moderate

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1/ E. A. Comman, California Forest and Range Experiment Station, 1945

2/ Wilting point

3/ Field capacity to pore space saturation.

4/ Water storage values are for the average soil depth, except for riverwash which is in inches per foot of depth.

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Table 4

Data for Representative Rainfall Stations in and Near the Santa Ana River Of California (Data from the Corps of Engineers, U. S. Army)

Station: Name	Station: Elevation	Period Of Record	Complete Years of Record	Mean Seasonal Precipitation*
NONRECORDING GAGES				
	Feet			Inches
San Bernardino	1,172	1870-1945	75	16.9
Tustin	200	1877-1945	68	13.1
Riverside	895	1881-1945	64	11.3
Big Bear Lake Dam	6,800	1883-1945	62	37.2
San Jacinto	1,550	1886-1945	54	13.6
Upland-Johnston	1,850	1891-1945	54	22.2
Beaumont	2,580	1888-1945	52	18.8
Elsinore	1,272	1867-1945	46	13.5
Lake Hemet Dam	4,350	1896-1941	45	19.5
Santa Ana River Powerhouse No. 1	2,850	1904-45	41	26.8
Corona-Temescal Water Co	680	1905-45	40	12.8
Lytle Creek	2,225	1905-45	40	34.2
Seven Oaks	5,000	1909-45	35	27.1
Pomona-Adamson	838	1913-45	32	18.7
Squirrel Inn No. 1	5,300	1894-1945	29	42.7
Camp Baldy	4,400	1916-1945	25	32.5
Bennett Ranch	1,750	1924-1945	20	25.7
Mentone-Crafton Orange Growers Association	1,650	1927-1945	17	16.4
Lytle Creek-Base Line	1,172	1926-1945	16	17.7
Kelly's Kamp	8,300	1931-1945	14	47.6
RECORDING GAGES				
Big Pines Recreation Camp County Park	6,860	1925-1945	20	25.8
March Field	1,537	1928-1943	15	10.2
Santa Ana-Hill & Son	133	1933-1941	8	13.3

* All records, except for the station at San Bernardino, were extended to cover the 73-year period 1870-1943.

Table 5

Estimated Mean Seasonal Rainfall and Run-off for Representative Drainage Areas In the Santa Ana River Basin of California, 1870-1943

(Data from the Corps of Engineers, U.S. Army)

Concentration Point of Drainage Area	Drainage Area	Mean Seasonal Rainfall	Mean seasonal run-off	
			Volume	Percent Of mean Seasonal Rainfall
	Square miles	Inches	Acre-feet	
Santa Ana River at mouth of canyon near Mentone	*189.0	31.0	74,200	23.7
Santa Ana River at Prado Dam .	**1,466.0	21.6	***108,600	6.5
Santa Ana River at mouth . .	*2,445.0	19.1	#29,000	1.2
Mill Creek near mouth of canyon	43.6	34.2	32,700	41.2
Lytle Creek near mouth of canyon	52.0	35.9	26,400	26.5
Cajon Creek above Keenbrook . .	40.9	24.0	6,650	12.7
Cucamonga Creek near mouth of canyon	10.1	34.8	5,650	30.1
San Timoteo Creek near Redlands	123.0	19.0	1,850	1.5
San Timoteo Creek at Little San Gorgonio Dam site	16.4	26.8	300	1.3
Yucaipa Creek at Yucaipa Dam site	40.4	21.3	700	1.5
Santiago Creek near Villa Park	84.0	20.5	##7,300	8.0

* Excludes 25 sq. mi. tributary to Baldwin Lake
** Excludes 767 sq. mi. tributary to Lake Elsinore and 25 sq. mi. tributary to Baldwin Lake
*** For 26-year period 1920-45
# For 50-year period 1895-1944
## For 15-year period 1931-45

Table 6

Estimated Flood Frequencies, Various Concentration Points in the Santa Ana River Basin of California

(Data from the Corps of Engineers, U.S. Army)

Number of Times that Flood Would be Equaled or Exceeded In 100 Years	Peak Discharge, Santa Ana River Near Mentone	Peak Discharge, Mill Creek Near Crafton Hills	Peak Discharge, Santa Ana River near Riverside Narrows	Peak Discharge, Warm Creek Below Confluence With East Twin Creek	Peak Discharge, San Jacinto River near San Jacinto
	Cubic feet per second	Cubic feet per second	Cubic feet per second	Cubic feet per second	Cubic feet per second
0.2	90,000	38,000	170,000	15,000	105,000
0.5	75,000	29,000	145,000	12,700	90,000
1.0	63,000	23,000	125,000	10,000	77,000
2.0	52,000	16,500	100,000	7,500	63,000
3.0	43,000	13,000	80,000	5,800	54,000
4.0	37,000	11,000	67,000	4,800	46,000
5.0	33,000	9,300	58,000	4,100	40,000
10.0	21,000	5,200	32,000	2,100	21,000
15.0	14,000	3,300	20,000	1,300	11,500
20.0	9,800	2,400	14,000	950	7,600
30.0	5,000	1,600	7,400	625	4,000

Table 7

Areas, Specific Yields, and Ground Water Storage Capacities
In Santa Ana River Basin of California
(From Calif. State Dept. of Public Works, Div. of Water Resources, Bull.#45
1934)

Ground Water Basins	Surface Areas (Acres)	Storage Capacity in Acre-Feet 50-foot Zone Above Water Table	 50-foot Zone Below Water Table	 Total 100-foot zone	Approximate Specific Yield of 100-foot zone
Upper Santa Ana Valley					
Chino	(a)129,500	536,000	583,000	1,119,000	9.0
Claremont Heights	3,220	9,400	9,000	18,000	6.0
Live Oak	1,730	4,100	4,000	8,100	5.0
Pomona	5,540	16,000	17,000	33,000	6.5
Cucamonga	7,940	27,000	27,000	54,000	7.0
Rialto-Colton --					
Rialto	14,420	60,000	60,000	120,000	8.5
Colton	8,210	50,000	43,000	93,000	11.5
Bunker Hill	(b) 50,950	257,000	243,000	500,000	10.0
Lytle	3,940	22,000	22,000	44,000	11.0
Devil Canyon	6,300	26,000	21,000	47,000	7.5
Yucaipa-Beaumont --					
Yucaipa	13,960	48,000	51,000	99,000	7.0
Beaumont	13,060	29,000	31,000	60,000	5.0
San Timoteo --					
North area	15,180	--	48,000	(c)48,000	(c) 6.5
Riverside	32,160	(d)51,000	156,000	(e)207,000	(e)11.0
Arlington	14,180	(f)14,000	(f)22,000	(c) 36,000	(c) 9.5
Temescal	16,170	(f)34,000	(f)36,000	(c) 70,000	(c) 9.0
Spadra	4,200	15,000	11,000	26,000	7.5
Totals	340,700	1,198,000	1,384,000	2,582,000	
Coastal Plain					
Santa Ana River Area	(g) 46,130	261,000	231,000	492,000	12.0
Irvine Area	(g) 24,940	64,000	62,000	126,000	5.5
LaHabra					
Upper zone	21,100	40,000	40,000	80,000	4.5
Lower zone	--	33,000	40,000	73,000	12.0
Yorba Linda	(h) 11,100	30,000	27,000	57,000	5.0
Totals	103,270	428,000	400,000	828,000	
TOTALS, SANTA ANA RIVER SUB-BASIN	443,970	1,626,000	1,784,000	3,410,000	

(a) Portion not included in storage change (18,700 acres), in SW cor. of basin is ex
(b) Portion not subject to storage change (6,270 acres), is excluded.
(c) Average thickness of zone is only 50 feet. (d) Average thickness of zone, 20 ft
(e) Average thickness of zone is only 70 feet. (f) Average thickness of zone, 25 ft.
(g) Includes only area in which storage change occurs. (h) Includes upper zone only.

Table 8

Population Trends and Forecasts for California and for the Counties in the Santa Ana River Basin of California
(Data from the California State Chamber of Commerce after the U.S. Bureau of Census, (1); and Julian Riley, Statistician, California Aeronautics Commission (2); and the U. S. Department of Commerce, Field Services, (3))

Counties	Census Enumerations (1)				Percent Increase From 1940 To 1950	1960 Census (2) Forecast
	1900	1920	1940	1950 (3)		
Riverside	17,897	50,297	105,524	168,959	60.1	240,000
San Bernardino	27,929	73,401	161,108	278,577	72.9	390,000
Orange	19,696	61,375	130,760	214,061	63.7	300,000
Santa Ana River Basin*	56,786	160,700	345,459	575,942	66.7	809,160
State of California	1,485,053	3,426,861	6,907,387	10,472,348	51.6	13,500,000

* The 1940 population of the Santa Ana River Basin was determined by summation of the census reports for minor civil divisions. Basin populations for other years were computed by assuming the same percentage distribution as existed in 1940, namely, 94.2% of Orange County, 73.8% of Riverside County, and 89.6% of San Bernardino County.

Table 9

Trend and Forecast of Population for the Santa Ana River Basin of California, Showing Portion of Basin Population Contributed by each County, and the Basin Total for the Period 1900-1960 (Data from the California State Chamber of Commerce after the U. S. Bureau of Census and Julian Riley, Statistician, California Aeronautics Commission.)

Counties	Percentage Of County Population In Basin	1900	1920	1940	1950	1960 Forecast
Riverside	73.8	13,208	37,119	77,877	124,692	177,120
San Bernardino	89.6	25,024	65,767	144,353	249,605	349,440
Orange	94.2	18,554	57,814	123,229	201,645	282,600
Santa Ana River Basin*		56,786	160,700	345,459	575,942	809,160

* The percent value was obtained by determining the number of people within the Basin in each county with the use of the 1940 census and determining the percent of the total 1940 county population this number represented. These percentages were then applied to the total county figures for other years to determine the portion of the Basin population contributed by each county.

Table 10

Wages Paid by Various Manufacturing Industries in the
Three Counties of the Santa Ana River Basin in 1943
(Data from California Blue Book, 1946, by Research Department, California State Chamber of Commerce)

Counties	Food Mfg.	Mill Products	Printing And Publishing	Petroleum Products	Stone, Clay And Glass Products	Transportation Equipment	Machinery	Chemical
Riverside	$1,329,400		$ 318,800		$2,266,100			
San Bernardino	2,643,400		528,400		1,611,100			$4,848,500
Orange	3,513,300	$ 465,700	367,100	$ 330,700	487,000	$4,787,200	$1,188,100	
Totals	$7,486,100	$ 465,700	$1,214,300	$ 330,700	$4,364,200	$4,787,200	$1,188,100	$4,848,500

Table 11

Type of Manufacturing and the Number of Establishments of Each Type In the Counties of the Santa Ana River Basin of California .
(Data from Department of Commerce, Census of Manufactures, 1939)

Type of Manufacture	Number of Establishments Orange County	 San Bernardino County	 Riverside County
Food and Kindred Products	55	57	40
Textile-mill Products and Other Fiber Manufactures	6		
Lumber and Timber Basic Products	4	4	1
Furniture and Finished Lumber Products	1	2	2
Printing, Publishing, and Allied Industries	23	22	19
Chemicals and Allied Products	4	8	1
Products of Petroleum and Coal	3		
Stone, Clay, and Glass Products	8	16	10
Iron and Steel and their Products, Except Machinery	5	4	4
Nonferrous Metals and their Products	3		
Electrical Machinery		2	
Machinery	10	3	5
Automobiles and Automobile Equipment	1		
Transportation Equipment Except Automobiles	5	1	
Miscellaneous Industries	5	3	1
Totals	133	122	83

Table 12

Manufacturing in the Counties of the Santa Ana River Basin of California
(Data from California Chamber of Commerce Presentation of Figures
from 1947 U.S. Census of Manufactures)

Counties	Number of Establishments		Production Workers		All Employed	Wages & Salaries	Value Added By Mfg.
	1939	194[illegible]	1939	1947	1947	1947	1947
Riverside	75	140	1,480	3,435	4,414	$11,112,000	$27,626,000
San Bernardino	113	256	2,487	8,703	11,186	33,817,000	75,795,000
Orange	117	299	2,083	4,723	6,100	16,761,000	31,158,000
Totals	305	695	6,050	16,861	21,700	61,690,000	134,579,000

Note -- Total county figures are presented because of the difficulty in obtaining figures for those portions of the above counties that lie within the boundaries of the Santa Ana River Basin.

Table 13

Acreage and Production Figures for the Counties which Comprise the
Santa Ana River Basin of California, 1949
(Data from the 1949 Annual Statistical Report of the Los Angeles Chamber of Commerce)

Counties	Area of County In Basin	Fruit Crop		Truck Crop		Field Crop		Total	
	Acres	Acreage	Tonnage	Acreage	Tonnage	Acreage	Tonnage	Acreage	Tonnage
Riverside	787,200	47,257	231,300	31,611	251,770	183,680	204,810	262,548	687,880
San Bernardino	640,000	82,046	296,210	8,511	87,240	42,319	100,190	132,876	483,640
Orange	354,560	66,491	530,320	13,445	76,280	65,946	99,900	145,882	706,500

Table 14

Value of Farm Products in Counties of the Santa Ana River Basin of California
(Data from Bureau of the Census, U. S. Department of Commerce, 1945)

Item	Orange County Census of 1945	Orange County Census of 1940	Riverside County Census of 1945	Riverside County Census of 1940	San Bernardino County Census of 1945	San Bernardino County Census of 1940
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
All farm products sold or used by farm households						
Total Value	63,698,723	14,403,999	45,798,101	12,543,603	55,953,450	15,925,050
Average Value per Farm	11,481	2,430	9,302	2,851	7,626	2,734
Fruits and nuts sold	46,927,107	7,709,255	24,410,240	5,073,678	34,066,197	8,073,336
Vegetables sold	2,497,731	1,128,924	3,743,134	916,308	754,978	185,659
Horticultural specialties sold	534,169	68,396	332,135	176,216	712,247	184,169
All other crops sold	4,719,006	2,346,154	8,248,126	2,836,363	2,031,804	944,729
Dairy products sold	4,500,828	1,565,031	1,644,216	813,190	4,678,285	1,825,996
Poultry & poultry products sold	1,636,841	1,044,594	3,079,484	1,371,098	8,423,181	2,779,798
Livestock and livestock products sold (other than dairy and poultry)	2,563,791	368,140	3,505,347	918,485	4,506,774	1,497,020
Forest products sold	6,054	811	2,136	5,447	1,042	3,416
Farm products used by farm households	313,182	172,694	828,283	432,818	778,942	430,927

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Table 15

Land Use Capability, Expressed in Acres, for the Santa Ana River Watershed
(Table Provided from the U. S. Forest Service Summary Report on Santa Ana River Watershed of California, May 1950)

Land Use	Land Use Capability Classes								
	Land Suitable for Cultivation				Land Not Suitable for Cultivation				
					Suitable for Range and Woodland			Suitable For Wildlife and Watershed	
	Very good Land With no Limitations	Good land With Minor Limitations	Moderately Good land With Major Limitations	Fairly good Land with Occasional Cultivation And major imitations	With no Limitations	With no Limitations	With no Limitations		
	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII	Class VIII	Total
Citrus	39,792	56,482	31,780	6,963		3,301			138,318
Deciduous orchard	8,125	18,600	7,612	1,653		412			36,402
Vineyard		23,339	9,469	1,304					34,112
Pasture and range		4,600	77,248	38,096		53,706	31,178		204,828
Truck and field	42,379	68,944	12,068						123,391
Cereal	840	49,220	79,973	14,161		3,617			147,811
Total cultivated and rangeland	91,136	221,185	218,150	62,177		61,036	31,178		684,862

Table 16

Mineral Production in Counties of the Santa Ana River Basin of California During 1947
(Data of the Division of Mines of the California Department of Natural Resources)

	Orange		Riverside		San Bernardino	
	Quantity	Dol. Value	Quantity	Dol. Value	Quantity	Dol. Value
Calcium, magnesium chloride					7,968 ST	111,950
Clay, raw	20,437 ST 1/	72,520	283,177 ST		63,491 ST	232,206
Clay products, heavy clay						
Coke					332,244 ST	
Copper					92,000 lbs	19,320
Gold			30 TO 2/	1,050	4,409 TO	154,315
Iron: Ore			27,029 LT 3/		346,545 ST	
Pig					453,376 ST	
Lead					158 ST	45,504
Lime					31,457 ST	328,329
Natural gas	29,399,000 M cu ft	2,465,000				
Natural gasoline & allied products						
Natural gasoline	115,423,000 gal.	5,911,000				
Liquified petroleum gases	4,528,000 gal.	150,000				
Petroleum	34,146,000 bbls.	58,274,000				
Salt (sodium chloride)					150,293 ST	386,742
Sand and gravel	961,207 ST	812,831	472,839 ST	517,871	1,151,258 ST	1,124,251
Silver			15 TO	14	103,877 TO	94,009
Stone			138,250 ST	156,700	558,580 ST	827,992
Talc					46,535 ST	997,446
Zinc					650 ST	157,300
Unapportioned 4/		169,480		7,705,580		32,220,545
Total Value		67,854,831		8,381,215		36,699,909

1/ Short Tons; 2/ Troy Ounce; 3/ Long Tons

4/ Boron minerals, bromine, cement, crude gypsum, iron ore, lithium minerals, peat, petroleum, potassium salts, raw clay, salt, silica (quarts), sodium salts, stone, tungston concentrates.

Table 17

Game Kill During 1948 in Parts of Counties Within the Santa Ana River Basin of California

(Data from the Bureau of Game Conservation of the California Division of Fish and Game)

Counties	Deer*		Brush & Cotton-tail Rabbits		Jack Rabbits		Quail**		Pheasants	
	a	b	a	b	a	b	a	b	a	b
Riverside	74	223	17,000	4,300	6,700	6,700	19,000	22,000	600	- -
San Bernardino	82	- -	5,700	10,700	3,300	7,200	5,800	8,000	- -	- -
Orange	- -	- -	6,900	6,900	3,900	4,200	5,300	10,300	600	- -
Totals	156	223	31,600	21,900	13,900	18,100	30,100	40,300	1,200	- -

Counties	Ducks		Geese		Doves		Band-tailed Pigeons	
	a	b	a	b	a	b	a	b
Riverside	8,000	13,000	300	- -	27,000	19,000	4,400	7,000
San Bernardino	19,000	20,000	100	- -	7,900	8,900	1,700	5,800
Orange	14,000	35,000	- -	- -	25,000	18,000	500	- -
Totals	41,000	68,000	400	- -	59,900	45,900	6,600	12,800

*a. Data based on postcard census (sampling rate, one in 50) taken by the Bureau of Game Conservation of the California Department of Natural Resources.

b. Data obtained by a hunter survey taken by the Opinion Research Center of Denver, Colorado, wherein a random sample (oral interviews) was taken of hunters throughout the State working under contract for the California Division of Fish and Game.

** All species.

Table 18

Principal Spreading Grounds Constructed by Local Interests, Santa Ana River Basin, California (1946)
(Data from Corps of Engineers, U. S. Army)

Stream	Location	Approximate area	Estimated cost
		Acres	
Santa Ana River	On debris cone at base of the San Bernardino Mountains	3,000	$400,000
Do	Along the river between Highway U S 101 bridge and the Santa Ana Mountains	300	40,000
Mill Creek	On debris cone between Mentone and canyon mouth	500	50,000
Wilson Creek	Near intersection of Oak Glen Rd. and Second St.	150	100,000
Yucaipa Creek	In upper Yucaipa Creek Valley	200	160,000
Waterman and East Twin Creeks	On debris cone below canyon mouth	400	200,000
Devil Creek	do	200	200,000
Lytle Creek	do	4,300	779,000
East Etiwanda Creek . .	do	800	100,000
Deer and Day Creeks . .	Between the San Gabriel Mountains and Highland Ave.	100	400,000
Cucamonga Creek . . .	Between the San Gabriel Mountains and Foothill Blvd.	1,000	515,000
San Antonio Creek . . .	On debris cone below canyon mouth	1,100	500,000
Totals.		12,050	$3,444,000

Table 19

Summary of Public Water Supply Information for Communities In the Santa Ana River Basin of California (Data from the California State Department of Public Health)

Communities	Source of Supply	Treatment	Population	Population Served	Consumption M.G.D.
1 Anza Development Arlington	Wells	none	400	400E	0.08E
2 Anaheim	5 wells 326' to 637' deep--94.9% water from M.W.D. used in 1948-49	M.W.D. water is lime-zeolite softened	14,522	14,522	0.12-- Local 2.30 M.W.D.
3 Arrowhead Springs Hotel	Springs	none	200	200	0.05
4 Big Bear City	Deep wells	none	2,800	3,700	0.50E
5 Beaumont	Beaumont Irrigation District. In winter run-off taken from Edgar Canyon--summer from wells	chlorination	3,143	4,760	0.56
6 Brea	Wells and C.M.W.D.	none	3,215	3,215	0.50E
7 Buena Park	Deep wells	none	2,491	2,500	0.50E
8 California Institution for Men, Chino	Deep wells	none	4,700	4,700	1.00E
9 Chino	Three wells 400' to 450' deep	none	5,877	5,800	1.50

Table 19 - Continued

	Communities	Source of Supply	Treatment	Population	Population Served	Consumption M.G.D.
10	Colton	Six wells 500' to 700' deep	none	14,382	13,000	1.50
11	Corona Creek	Coldwater Creek, Mayhew Creek, three wells 200' deep	chlorination	10,219	10,000	1.10
12	Costa Mesa	Four districts--two take water from C.M.W.D.--two from deep wells, 30% from C.M.W.D.	water from C.M.W.D. is lime-zeolite softened	7,500	7,500	0.75E
13	Elsinore	Two wells 500' deep	none	2,054	2,054	0.50E
14	Fullerton	Deep wells--39% of water from M.W.D. in 1948-49	M.W.D. water lime-zeolite softened	13,939	12,000	1.77 Loc. 1.14 MWD
15	Garden Grove	Three wells 150' deep	none	3,000	2,800	0.25
16	Hemet	N&S Forks San Jacinto River	chlorination	3,371	3,500	0.40E
17	Huntington Beach	Three wells 201' to 282' deep Southern California Water Co.	chlorination	5,258	5,258	1.40E
18	Loma Linda	Eight wells 220'-800' deep	none	2,500	2,250	1.20
19	Los Alamitos	Deep wells, Southern California Water Co.	none	1,000	1,000	0.20E
20	March Air Force Base	Five wells (2 at Gregory, 3 on Post) Take from M.W.D.-softened at Camp Haan	M.W.D. softened with Lime-Soda Ash at Camp Haan Chlor.	5,000	5,000	1.25

Table 19 Continued

	Communities	Source of Supply	Treatment	Population	Population Served	Consumption M.G.D.
21	Newport Beach	Deep wells-10% from C.M.W.D.	C.M.W.D. water lime-zeolite softened Chlorinated	12,220	13,000	3.00E
22	Ontario	Six wells 550' - 672' deep	none	22,820	18,000	2.50E
23	Orange	Wells	none	10,053	11,000	2.20E
24	Patton State Hosp.	Two deep wells	none	5,000	5,000	0.70
25	Perris	Three wells 235' - 424' deep	none	1,796	1,796	0.18E
26	Placentia	Deep wells-So.Calif. Water Co.	none	1,681	2,400	0.50E
27	Redlands	500 to 600 miners inches from Mill Creek--20 Wells 350-800' deep--also used for irrigation	Coagulation, Filtration, Chlorination of Mill Creek Supply	18,407	25,000	12.00
28	Rialto	Lytle Creek (43. miners inches) Well 430' deep	Chlorination	3,148	3,100	0.50
29	Riverside	25 wells 400' to 1,100' deep	none	46,399	50,000	7.50
30	San Bernardino	Two creeks - 18 wells	Chlorination of creek supplies	62,694	60,000	7.10
31	San Jacinto	Five wells 200' to 220' deep	Chlorination	1,760	1,760	2.50
32	Santa Ana	Seven wells 900' to 1,140' deep--used 84.7% M.W.D. water in 1948-49	M.W.D. water lime zeolite softened	45,534	45,000	0.91 Loc. 5.05MWD

Table 19 - Continued

Communities	Source of Supply	Treatment	Population	Population Served	Consumption M.G.D.
33 Sunset Beach	Wells 453' - 651' deep	none	2,800	2,800	0.30
34 Seal Beach	Deep wells	none	3,558	3,558	0.75E
35 Tustin	Three wells 400' to 940' deep	none	1,140	2,100	0.20
36 Upland	Four wells 140' - 900' deep Infiltration tunnel	none	6,125	6,700	1.35
37 Westminster	Deep wells	none	1,000	1,000	0.30
Totals			351,706	356,373	66.11

C.M.W.D. = Coastal Municipal Water District
M.W.D. = Metropolitan Water District of Southern California
E = Estimated

Table 20

Principal Existing Water-conservation Reservoirs Constructed by Local Interests, Santa Ana River Basin of California
(Data from Corps of Engineers, U.S. Army)

Stream	Reservoir			
	Name	Design Capacity*	Year Completed	Total Cost
		Acre-feet		
Cajalco Creek	Lake Mathews**	104,000	1938	$6,849,000
Bear Creek	Bear Lake	72,000	1911	149,000
Santiago Creek	Santiago	25,000	1931	741,000
South Fork, San Jacinto River	Lake Hemet	14,000	1895	213,000
San Jacinto River	Railroad Canyon	12,000	1928	268,000
Mockingbird Creek	Mockingbird Canyon	1,000	1914	105,000
Totals		228,000		$8,325,000

* At Spillway crest.

** Metropolitan Water District of Southern California. (Used for storage of Colorado River Water.)

Table 21

Monthly Fish Catches by Newport Beach Sportsmen
Of the Santa Ana River Basin of California
During the Period May 1949 – April 1950
(Data provided by the California Division of Fish and Game)

	May	June	July**	Aug.	Sept.	Oct.**	Nov.	Dec.	Jan.	Feb.	Mar.	April	Total No. Of Fish Caught
Number of Fishermen	*	20,568	24,324	*	*	*	*	*	171	895	*	4,944	--
Kelp bass and sand bass	26,130	36,810	29,030	19,290	7,410	5,080	940			350	1,514	6,780	133,334
Barracuda	2,470	74,690	11,640	7,080	580	160						360	96,980
Pacific mackerel		2,940	5,670	7,270	1,580								17,460
Rockfish	2,800						780	500	660	290			5,030
Kingfish				3,370							450		3,820
California halibut	5,480	3,060	1,320	2,200	710	380				370	570	4,500	18,590
Bonito		800											800
Sculpin	1,260	410								750	430	2,520	5,370
White sea bass		690	3,080	4,040	5,000	3,080	870				300		17,060
Albacore			7,600	4,830									12,430
Yellowtail		380											380
Others	3,790	900	2,600	2,580	1,080	510	330	90	100	50	530	1,200	13,760
Totals	41,930	120,680	60,940	50,660	16,360	9,210	2,920	590	760	1,810	3,794	15,360	325,014

* Figures not available.
**Figures for July include Seal Beach and Balboa; for October, San Clemente.

Table 22

Estimated Number of Fisherman and Fish Caught (Expressed in Thousands) During 1948
Within the Counties that are Wholly or Partly Within the Santa Ana River Basin of California
(Data from the Bureau of Fish Conservation of the California Division of Fish and Game)

Counties	Trout		Crappie		Sunfish		Black Bass		Catfish	
	Fishermen	Fish Caught	Fishermen	Fish Caught	Fishermen	Fish Caught	Fishermen	Fish Caught	Fishermen	Fish Caught
Riverside	2.2	30	2.3	41	3.2	151	5.3	91	4.1	70
San Bernardino	43.9	958	18.0	399	14.8	476	11.0	154	12.8	185
Orange	1.5	25	6.0	133	5.5	210	3.1	47	4.0	77
Totals	47.6	1,013	26.3	573	23.5	837	19.4	292	20.9	332

Table 23

The Value and Poundage of the 1947 Landings of Seafood Products
At Newport Beach in the Santa Ana River Basin of California

(Data from Fish Bulletin No. 74 of the California
Division of Fish and Game, page 262, 1949)

Species	Value	Pounds
Pacific mackerel	$259,527	8,679,846
Broadbill swordfish	107,957	346,015
Albacore	67,861	293,139
Sardine	58,012	2,601,415
Barracuda	38,351	287,057
Shark	37,394	155,807
Spiny lobster	21,332	59,956
California halibut	20,514	103,658
Anchovy	20,146	875,921
Skipjack tuna	19,837	138,620
Bluefin tuna	16,108	100,991
Yellowtail	12,994	115,301
Abalone	7,655	71,008
All other	49,553	581,035
Totals	$737,241	14,409,769

Table 24

Municipal Sewage Treatment Plant Information
For the Santa Ana River Basin of California

(Data from the California State Department of Public Health)

	Municipalities	Connected Population	Estimated Pop. Equiv. Of Industrial Wastes	Estimated Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Disposal of Effluent
1	Anza Development Arlington	400	none	40	Primary Clarifier, Digester, Bio filter, Chlorinator	Percolation beds
2	Anaheim	Included with Orange County Joint Outfall Sewer				
3	Arrowhead Springs Hotel	200	none	20	Imhoff tank, Trickling filter, Final clarifier, Rapid sand filter, Chlorinator	To Twin Creeks
4	Beaumont	2,250	none	225	Bar Screen Primary clarifier, Trickling filter, Digester	Percolation beds
5	Big Bear Lake	1,500	none	900	Primary Clarifier, Digester	Percolation beds
6	Bixby Ranch	250	none	170	Septic Tank	Santa Ana River
7	Brea	4,000	Unknown	1,600	Imhoff tank, Trickling filter, final settling basin, Chlorinator	Irrigation and percolation beds

Table 24 - Continued

	Municipalities	Connected Population	Est.Pop. Equiv. Of Indus- trial Wastes	Est. Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Dis- posal of Effluent
8	Buena Park Sanitary Dist.	Included with Orange County Joint Outfall Sewer				
9	Cal-Aero Housing Area	500	none	250	Imhoff tanks, Oxidation lagoons	Percolation beds
10	California Institution for men at Chino	1,500	none	100	Primary clarifier, Activated sludge, Final clarifier, Chlorinator	Irrigation
11	Camp Haan	300	March Air Force Base Laundry Wastes	30	Primary clarifier, Bio filter, Secondary clarifier	Percolation beds
12	Chino	4,700	Unknown	1,700	Chemical clarifier, Bio filter, stage digester	Irrigation
13	Colton	10,000	Unknown	1,000	Primary clarifier Activated sludge Secondary clarifier, Digester, Chlorinator	Santa Ana River
14	Corona	11,000	Unknown	1,100	Primary clarifier Trickling filter, Secondary clarifier, Digester, Chlorinator	Percolation beds
15	Elsinore	3,100	Unknown	2,200	Imhoff Tank	Irrigation

Table 24 - Continued

	Municipalities	Connected Population	Est.Pop. Equiv. Of Industrial Wastes	Est.Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Disposal of Effluent
16	El Toro Marine Air Station	8,000	none	800	Primary clarifier, Bio filter, Secondary clarifier, Digester, Chlorinator	Percolation beds
17	Fullerton	Included with Orange County Joint Outfall Sewer				
18	Garden Grove Sanitary Dist.	Included with Orange County Joint Outfall Sewer				
19	Hemet	3,000	Unknown	1,000	Aerators, Chemical floculators, Clarifiers (Oxidators) Digester	Irrigation
20	Huntington Beach	7,000	none	1,400	Primary clarifier, Trickling filter, Digester, Chlorinator.	To tidal waters of Santa Ana River
21	La Habra Sanitary Dist.	Included with Orange County Joint Outfall Sewer				
22	La Sierra	600	none	400	Septic tank, Chlorinator	Irrigated pasture
23	Loma Linda	2,250	Unknown	400	Primary clarifier, trickling filter, Secondary clarifier, Digester	Irrigation
24	Los Alamitos Naval Air Station	900	none	100	Clarigester, Trickling filter, Clarigester	To tidal waters of San Gabriel River

Table 24 - Continued

	Municipalities	Connected Population	Est.Pop. Equiv. Of Industrial Wastes	Est.Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Disposal of Effluent
25	March Air Force Base	1,000	none	100	Primary clarifier, Trickling filter, Final clarifier, Digester	Irrigation
26	Mira Loma Army Quartermasters Depot	100	none	10	Clarigester, Bio filter, Secondary clarifier	Percolation beds
27	Newport Beach	Discharged to Orange County Joint Outfall Sewer				
28	Norco Naval Hospital	135	none	15	Primary clarifier, Bio filter, Secondary clarifier, Chlorinator	Percolation beds
29	Ontario	15,000	Unknown	1,750 Including Upland	Preaerator, primary clarifier, trickling filter, Secondary clarifier, Digester, Chlorinator	Irrigation
30	Orange	Included with Orange County Joint Outfall Sewer				
31	Orange County Joint Outfall Sewer	118,100	360,000	320,000	Primary clarifiers, Digesters, Chlorinators	To ocean outfall
32	Patton State Hospital	5,000	none	500	Primary clarifier, Trickling filter, Secondary clarifier, Digester, Chlorinator	Irrigation
33	Perris	600	Unknown	240	Imhoff Tank Oxidation ponds	Irrigation Percolation beds
34	Placentia Sanitary Dist.	Included with Orange County Joint Outfall Sewer				

Table 24 - Continued

	Municipalities	Connected Population	Est.Pop. Equiv. Of Industrial Wastes	Est.Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Disposal of Effluent
35	Redlands	19,500	Unknown	13,600	Imnoff tank	Percolation beds
36	Rialto	1,800	Unknown	450	Imhoff tank, Trickling filter, Chlorinator	Irrigation Percolation beds
37	Riverside	42,000	Unknown	2,500	Chemical floculator, Primary Clarifier, Trickling filters, Final clarifiers, Digesters, Chlorinators	Santa Ana River
38	San Antonio Canyon Property Assoc. Camp Baldy	125	none	100	Septic tank	Percolation beds
39	San Bernardino	62,000	Unknown	4,400	Aerators, Primary clarifier, Trickling filters, Final clarifier, Digesters, Chlorinators.	Irrigation or Santa Ana River
40	Norton Air Force Base (San Bernardino)	Included with San Bernardino				
41	San Jacinto	650	Unknown	450	Primary clarifier, Digester	Percolation
42	Santa Ana	Included with Orange County Joint Outfall Sewer				
43	Seal Beach	3,750	Unknown	750	Aerator, Primary clarifier, Trickling filter, Chlorinator, Digester	To tidal waters of San Gabriel River

Table 24 - Continued

	Municipalities	Connected Population	Est. Pop. Equiv. Of Industrial Wastes	Est. Pop. Equiv. Of Plant Effluent	Treatment Units Provided	Final Disposal of Effluent
44	U.S.Navy Net and Ammunition Depot (Seal Beach)	320	none	190	Imhoff tank	To ocean
45	Sunset Beach Sanitary Dist.	2,800	Unknown	2,000	Primary clarifier, Digester, Chlorinator	To ocean
46	Upland	2,500	Treated at Ontario Plant			
47	U.S. Navy Lighter-than-Air Base	Included with Santa Ana and the Orange County Joint Outfall Sewer				
	TOTALS 46	336,830	360,000	360,490		

Table 25

Average Annual Floodwater and Sediment Damages in the Santa Ana River Basin of California
(Taken from the U. S. Forest Service Survey Report on Santa Ana River Watershed of California, May 1950)

Damage areas	Average Annual Flood Damages	Average Annual Sediment Damages	Total Average Annual Damages
San Antonio	$ 24,300	$ 358,900	$ 383,200
Cucamonga-Fontana area	77,500	293,000	370,500
Lytle-Cajon	144,500	872,500	1,017,000
Cable-City Creek area	36,500	306,100	342,700
Santa Ana River above Mentone	43,300	1,076,000	1,119,300
San Timoteo area	59,500	291,200	350,700
San Jacinto River area	21,800	549,800	571,600
Lower Santa Ana River	64,600	495,900	563,700
Totals	$472,000	$4,243,900	$4,716,000

Table 26

Permissible Limits for Boron of Several Classes of Irrigation Water*

Classes of Water	Crop Groups		
	Sensitive	Semitolerant	Tolerant
	p.p.m.	p.p.m.	p.p.m.
Excellent	0.33	0.67	1.00
Good	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00
Permissible	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00
Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
Unsuitable	1.25	2.50	3.75

Table 27

Relative Tolerance of Crop Plants to Boron (In Each Group the Plants First Named are Considered as Being More Sensitive and the Last Named More Tolerant)*

Sensitive to Boron	Semitolerant to Boron	Tolerant to Boron
Lemon	Lima bean	Carrot
Grapefruit	Sweet potato	Lettuce
Avocado	Bell pepper	Cabbage
Orange	Tomato	Turnip
Thornless blackberry	Pumpkin	Onion
Apricot	Zinnia	Broadbean
Peach	Oat	Gladiolus
Cherry	Milo	Alfalfa
Persimmon	Corn	Garden beet
Kadota fig	Wheat	Mangel
Grape (Sultanina and Malaga)	Barley	Sugar beet
Apple	Olive	Palm (Phoenix canariensis)
Pear	Ragged Robin rose	Date Palm (P. dactylifera)
Plum	Field pea	Asparagus
American elm	Radish	Tamarix, or athel (Tamarix aphylla ant T. Gallica)
Navy bean	Sweet pea	
Jerusalem-artichoke	Pima cotton	
Persian (English) walnut	Acala cotton	
Black walnut	Potato	
Pecan	Sunflower (native)	

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* Explanation and Interpretation of Analyses of Irrigation Water by L.V. Wilcox, U. S. Department of Agriculture. Circular No. 784. May 1948.

Table 28

Summary of Estimated Population for Each of the Proposed Orange County Sanitation Districts Nos. 1 to 10, Inclusive
(Data from Orange County Sewerage Survey - June 30, 1947)

County Sanitation District Number	Area (Acres)	Total Population			Population Density (Persons per Acre)		
		1950	1970	1990	1950	1970	1990
1	12,051	57,000	119,600	165,300	4.7	9.9	13.8
2	60,689	72,400	224,000	390,200	1.2	3.7	6.4
3	57,931	49,600	149,200	304,800	0.9	2.6	5.2
4	14,343	12,600	29,300	51,800	0.9	2.0	3.6
5	11,957	25,100	79,500	125,900	2.1	6.7	10.5
6	9,839	14,800	47,600	96,300	1.5	4.8	9.8
7	53,491	35,500	79,300	167,600	0.7	1.5	3.1
8	5,095	12,600	32,600	59,700	2.5	6.4	11.7
9	10,138	8,300	34,900	99,300	0.8	3.4	9.8
10	1,929	1,600	4,300	9,300	0.8	2.2	4.8
1 to 10	237,463	289,500	800,300	1,470,200	1.2	3.4	6.2

Table 29

Summary of Sewage Flow for Each of the Proposed Orange County
Sanitation Districts Nos. 1 to 10, Inclusive
(Data from Orange County Sewerage Survey - June 30, 1947)

County Sanitation District Number	Sewage Flow (Millions of Gallons per 24 Hours)							
	Year Average				Maximum Average			
	1950	1970	1990	Aver.	1950	1970	1990	Aver.
1	5.69	10.98	14.84	10.50	6.66	12.10	16.07	11.54
2	7.65	23.74	41.67	24.35	8.36	25.36	44.32	26.01
3	4.44	17.10	36.90	19.48	5.43	18.96	40.13	21.51
4	1.12	2.82	5.12	3.02	1.12	2.88	5.29	3.10
5	3.67	12.03	19.18	11.63	3.61	12.10	19.36	11.69
6	1.19	4.82	10.40	5.47	1.19	5.03	10.98	5.73
7	2.52	6.08	13.22	7.27	2.54	6.16	13.43	7.38
8	1.07	2.78	5.04	2.96	1.16	3.02	5.52	3.23
9	0.76	2.97	8.43	4.05	0.77	3.23	9.18	4.39
10	0.10	0.26	0.56	0.31	0.11	0.30	0.65	0.35
1 to 10	28.21	83.58	155.36	89.05	30.95	89.14	164.93	94.93

Table 30

Summary of Estimated New Construction and Purchase Costs
For Each of the Proposed Orange County Sanitation Districts Nos. 1 to 10, Inclusive
(Data from Orange County Sewerage Survey - June 30, 1947)

County Sanitation District Number	New Construction and Purchase Costs (Dollars)				
	1950	1960	1970	1980	Total
1	2,005,000	42,000	43,000	39,000	2,129,000
2	5,405,000	865,000	197,000	194,000	6,661,000
3	6,489,000	325,000	301,000	209,000	7,324,000
4	1,307,000	21,000	44,000	26,000	1,398,000
5	1,813,000	104,000	75,000	76,000	2,068,000
6	1,109,000	42,000	55,000	70,000	1,276,000
7	2,613,000	44,000	63,000	87,000	2,807,000
8	1,260,000	75,000	52,000	31,000	1,418,000
9	1,134,000	94,000	349,000	41,000	1,618,000
10	217,000	84,000	78,000		379,000
1 to 10	23,352,000	1,696,000	1,257,000	773,000	27,078,000

Table 31

Summary of Estimated Annual Costs
For Each of the Proposed Orange County Sanitation Districts Nos. 1 to 10, Inc.
(Data from Orange County Sewerage Survey - June 20, 1947)

County Sanitation District Number	Total Annual Costs (Thousands of Dollars)				Assessed Valuation (Millions of Dollars)				Tax Rate (Cents/$100 Ass'd.Val.)			
	1950	1970	1990	Aver.	1950	1970	1990	Aver.	1950	1970	1990	Aver.
1	119	99	82	100	45	101	142	96	26	10	6	12
2	291	291	255	283	83	219	369	224	35	13	7	16
3	334	306	284	306	56	145	286	163	59	21	10	26
4	74	68	64	68	16	31	52	33	45	22	12	24
5	100	97	89	96	43	92	133	89	23	11	7	12
6	58	58	60	58	8	38	82	43	69	15	7	23
7	136	114	100	116	26	65	145	79	52	18	7	22
8	79	80	85	81	13	31	55	33	62	26	15	31
9	64	74	83	74	7	31	89	43	87	24	9	31
10	14	18	16	16	1	3	8	4	222	58	21	53
1 to 10	1,269	1,205	1,118	1,198	298	756	1,361	807	53	16	8	16

Table 32

Orange County Sewerage Survey, Estimated Amounts of B.O.D.
From Sanitation Districts Nos. 1-8, 1950
(Data from Orange County Sewerage Survey - 1946--1947)

County Sanitation District Number	Estimated B.O.D.-Tons Per Day - 1950				
	Year Average			Industry Maximum Month	Dom. Year Aver. Plus Ind. Max. Month
	Domestic	Industry	Domestic Plus Industry		
1	3.1	9.1	12.2	17.3	20.4
2	4.1	11.7	15.8	24.0	28.1
3	2.8	4.9	7.7	13.5	16.3
4	0.7	0.2	0.9	0.2	0.9
5	1.5	0.9	2.4	0.9	2.4
6	1.2	0.4	1.6	0.4	1.6
7	1.5	0.1	1.6	0.1	1.6
8	0.7		0.7		0.7
TOTALS	15.6	27.3	42.9	56.4	72.0

State Water Pollution Control Board

RESOLUTION NO. 51-12
APPROVING AND CONFIRMING THE ACTIONS OF THE INTERIM COMMITTEE ON ACTIVITIES CONNECTED WITH PUBLIC LAW 845 REGARDING A REPORT ON WATER POLLUTION CONTROL FOR THE SANTA ANA RIVER SUB-BASIN OF CALIFORNIA

WHEREAS, on April 23, 1951, the State Board was requested to review, comment, and give clearance at the earliest practical date to "A Report on Water Pollution Control for the Santa Ana River Sub-basin of California" dated March 1, 1951, and prepared by the California and Great Basin Drainage Basins Office, Division of Water Pollution Control, U.S. Public Health Service, San Francisco; and

WHEREAS, by Resolution No. 51-5 the State Board on May 3, 1951, directed the Chairman of said Board to appoint an Interim Committee on Activities Connected with Public Law 845, which Committee was authorized, subject to final action and approval of the State Board, to examine, review, suggest amendments, and give clearance for said Report; and

WHEREAS, the Chairman appointed Board members Mrs. Baeskens (chairman), Mr. Arnold, and Dr. Halverson as the Interim Committee on Activities Connected with Public Law 845; and

WHEREAS, said Committee met in Los Angeles on June 1, 1951, discussed changes in said Report which were suggested by the Santa Ana Regional Water Pollution Control Board (Region No. 8), the Division of Fish and Game, the Division of Water Resources, the Department of Public Health, the State Board Executive Office, and members of the State Board, and approved a letter dated June 8, 1951, giving clearance for release and reproduction of said Report provided the changes recommended by the Committee were incorporated in said Report;

NOW, THEREFORE, BE IT RESOLVED that the actions of said Interim Committee and the letter dated June 8, 1951, giving clearance for release and reproduction of said Report be approved, ratified, and confirmed; and

BE IT FURTHER RESOLVED that the additional changes in said Report suggested in the letter dated June 18, 1951, from the Santa Ana Regional Water Pollution Control Board to the State Board be incorporated in said Report prior to release and reproduction; and

BE IT FURTHER RESOLVED that the Executive Officer of the State Board be directed to forward a copy of this Resolution to the California and Great Basin Drainage Basins Office, Division of Water Pollution Control, U. S. Public Health Service, San Francisco, California, and to the Santa Ana Regional Water Pollution Control Board.

Warren T. Hannum
Chairman

SANTA ANA RIVER BASIN OF CALIFORNIA

Exhibit 1

DATA ON
OIL FIELDS IN THE SANTA ANA RIVER BASIN

By F. H. Dierker, Jr.
Assistant Sanitary Engineer
State Department of Public Health

March 27, 1950

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The major oil producing areas in the Santa Ana River Basin are all in the County of Orange. This county has its own industrial waste ordinance in force and retains the services of Mr. Loren Blakeley, Consulting Civil Engineer, for water pollution studies. The following data were obtained in a conversation with Mr. Blakeley on March 21, 1950.

The major oil fields or producing areas together with a brief statement of the brine disposal methods employed are shown in the following tabulation:

1. Newport Field - Brines are put into the Talbert Drainage Dist. lines which discharge near the mouth of the Santa Ana River.
2. Huntington Beach Field - Some brines are carried to the beach in lines owned by the oil companies, some are carried to the ocean through the city streets and others drain to the north and east into water bearing lands. Two horizons of water bearing material have been contaminated with oil brine wastes in the area north of Huntington Beach.
3. Murphy - Coyote Lease (located northwest of Fullerton) - Brine wastes from this field presently go to the Santa Fe Waste Water Disposal Company. There are believed to be some oil wells south of this field that discharge their brines into open sumps. These are being investigated as rapidly as time permits.
4. Richfield, Yorba Linda, Atwood Area - The major brine producers - (major oil operators) dispose into the Waste Water Disposal Co. system which treats the brine for the removal of oil and then discharges the effluent into the Orange Co. Joint Outfall Sewer.
5. Placentia, Carbon Canyon, Fullerton Dam Area - All of these fields send a major portion of their brines to the Waste Water Disposal Co. There are still many small operators (individual wells) that probably discharge brines where they may pollute the underground water. These are being corrected as quickly as possible.

A water well in the northwest corner of Brea has been polluted with casinghead gasoline. A great deal of investigation has been done, but no definite source of the pollution has been established.

A water well in the vicinity of the Yorba Linda reservoir has been polluted with material that has presumable leached from an old acid sludge dump above the well. The investigation here was quite complete; the dump is no longer used for any purpose and the well is intermittently polluted with a disagreeable odor.

An abandoned acid sludge dump in the Bolsa Chica area (at the intersection of Wintersburg Ave. and Bolsa Chica Ave.) is being investigated to determine the character and quantity of pollutants leached from the acid sludge. There are no known active acid sludge dumps in Orange County (or the Santa Ana River Basin) at the present time.

NOTE: For pollution control purposes Mr. Dierker has grouped the major oil producing areas into five fields rather than eight as listed by State Division of Oil and Gas.

Exhibit 2

Tel: 1991-W

LOREN E. BLAKELEY
Consulting Civil Engineer
1112 Kilson Drive
Santa Ana, California

March 8, 1949

Mr. Edward M. Mahl
Building Inspector
County of Orange
Court House Annex
Santa Ana, California

Subject: Progress Report, Brea Canyon Investigation

Dear Mr. Mahl:

Conditions disclosed by the investigation to date show much more serious pollution problems than were first anticipated. Three samples of ground water and three samples of surface water have been analyzed. The results of these are shown in the following table. Additional samples have just been gathered at what appears to be a suitable site for an underground dam north of Central Avenue and a short distance south of the Brea Canyon Oil Company refinery. The analyses of these latter samples will take some time to run as there appears to be both gasoline and crude oil pollution at depths as much as 6 feet. The State Health Department is cooperating in some of this work in view of the unique problems encountered here which have not come to its attention elsewhere.

The alkali coefficient shown in the following table is a modified method of computing the inches of water which evaporated in a 4-foot undrained column of soil would leave sufficient sodium chloride to be harmful to sensitive citrus roots. It is an empirical formula developed from original work by Mr. Herman Stabler by the Union Oil Company for use in its citrus properties on the Bastanchury ranch. It furnishes a measure by which various waters can be compared for sodium chloride effect on plant life. It, of course, must be used with percent sodium, boron content and other known standards of tolerance to determine whether the water should be allowed to reach Brea Basin ground water, or whether it should be wasted into the ocean disposal system.

BREA CREEK COMPARATIVE MINERAL ANALYSES-GROUND & SURFACE WATERS

	Modified Alkali Coefficient	% Sodium	Parts Per Million				
			Magnesium	Sodium	Sulfate	Chloride	Boron
G_1	7.3 inches	44.3%	279	706	1980	625	0.4
G_2	0.9 "	---	---	---	720	1937	---
G_3	0.6 "	65.3%	262	1595	607	2761	1.1
S_1	10.9 "	66.2%	81	491	585	366	.0
S_2	12.7 "	66.3%	69	401	453	371	.0
S_3	11.5 "	65.6%	72	432	545	441	1.4

Water samples analyzed to date show the water both surface and underground in Brea Canyon to be polluted with chemicals in addition to oil wastes previously reported. The situation is serious whether viewed from use as agricultural or domestic water supply. Sample G_1, ground water at the bridge between Tonner No. 11 and No. 12 wells near the east end of the oil field, has a boron content of 0.4 parts per million. The accepted safe upper limit for citrus irrigation is generally accepted as 0.5 ppm. Sample S_3, surface water flowing in the bed of Brea Creek 150 feet downstream from Highway Bridge 55-34, near Central Ave. on Pomona Ave., with 1.4 parts per million of boron has nearly three times the upper limit for citrus.

Ground water at road bridge between Tonner Wells No. 11 and No. 12 with an alkali coefficient of 7.3" is only slightly above the normal classification of Poor water and would require loose soil and special care to prevent root damage and gradual alkali accumulation in the soil. Ground water under Bridge 55-34 (north of Central Ave.) with alkali coefficient of 0.9" to 0.6" is practically useless for irrigation and would ruin tight soil for citrus growing in a few irrigations.

Surface flow in Brea Creek on February 9, 1949, following the rainy period, shows the effect of inflow into the stream from surface percolation. This phenomenon also was observed in the field when sands above confining silt layers were found to contain fresh water, while gasoline charged water was brought up after the test hole was dug through the confining layer about 10 to 14 inches below the ground surface. Upon ignition by a paper match the hydrocarbons burned in the hole for some time, but were extinguished when ground water rose up into the black silt layer.

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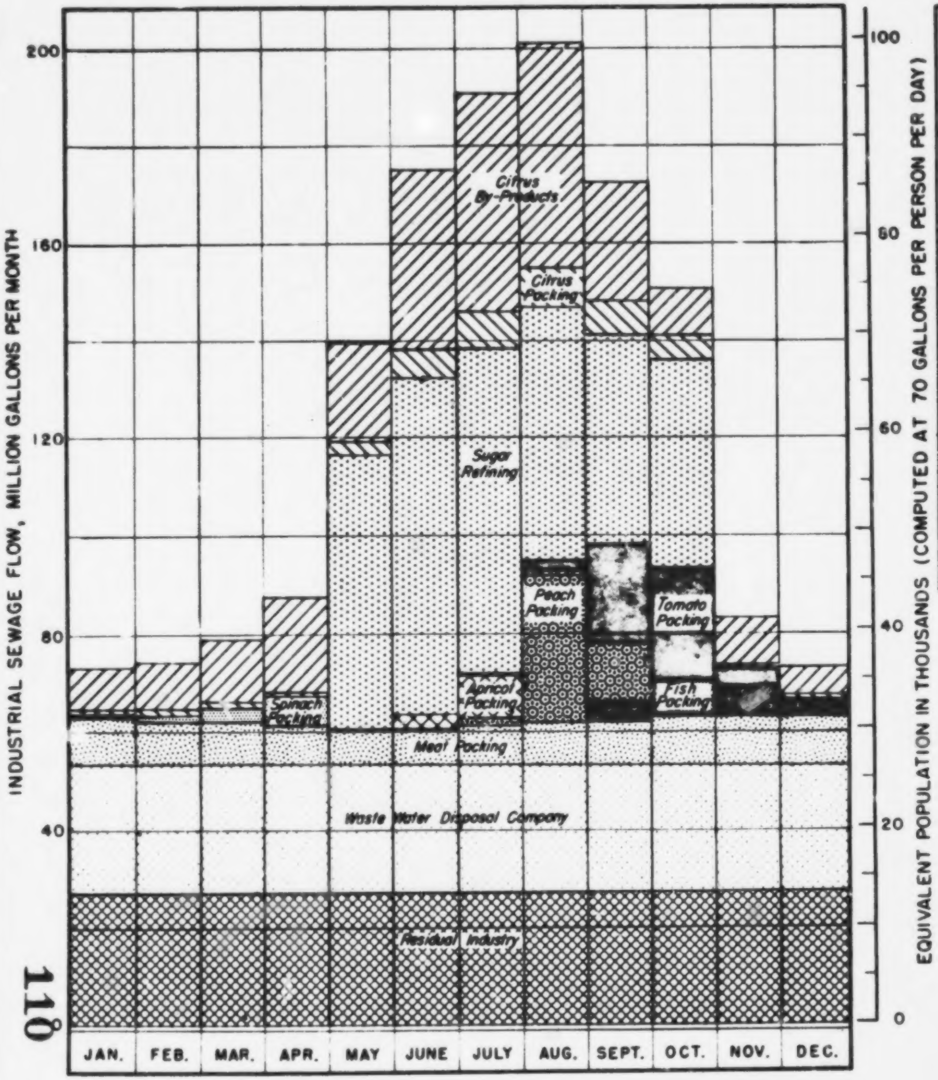
The range in alkali coefficient of 10.9", 12.7" and 11.5" from upstream to downstream indicates a maximum rainfall and rising water effect at the waterfall Bridge 55-33 and a picking up of sodium chloride between that point and Bridge 55-34 located about 1,000 feet downstream. While this water would be in the Fair classification for irrigation purposes based on alkali coefficient alone, it is entirely unsuited for domestic purposes according to standards for Drinking Water set by the U.S. Public Health Service. Its percent sodium of 66% together with the 1.6 ppm. of boron render it unfit for citrus culture on heavy soil. Spreading of such water in a basin from which domestic water is obtained creates certain hazards due to the uncertainty of dilution with sufficient rain water to provide a suitable blend.

Negotiations have been started with the major oil companies located in this area. They have started their own investigations in an endeavor to locate the sources of the various types of pollution now known to exist. It is hoped that an exchange of basic data can be effectuated.

Very truly yours,

/s/ Loren E. Blakeley
Loren E. Blakeley
Consulting Engineer
Orange County Bldg. Dept.

LEB:fw



MILLION GALLONS PER MONTH OF SEWAGE FLOWS FROM INDUSTRY FOR ORANGE COUNTY FOR 1947 (BASED ON MEASUREMENTS TAKEN IN 1946-47)

TYPE OF INDUSTRY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
CITRUS BY-PRODUCTS	9.2	10.0	13.7	19.0	20.7	37.3	45.5	45.6	24.9	10.0	9.5	6.1
CITRUS PACKING	1.1	1.4	1.0	0.9	2.4	6.6	7.5	8.7	7.0	4.9	0.8	0.9
SUGAR REFINING	0	0	0	0	56.5	67.9	67.1	51.1	42.8	42.8	0	0
TOMATO PACKING	0	0	0	0	0	0	0.1	3.3	20.2	22.5	3.4	0
APRICOT PACKING	0	0	0	0	0	3.6	8.2	0.4	0	0	0	0
PEACH PACKING	0	0	0	0	0	0	1.8	29.7	12.0	0	0	0
SPINACH PACKING	0	1.1	2.6	6.1	0	0	0	0	0	0	0	0
FISH PACKING	0.3	0	0	0	0	0	0	0	4.0	7.8	6.4	3.5
MEAT PACKING	9.5	8.5	8.5	7.6	6.6	6.6	7.6	8.5	8.5	9.5	9.5	9.5
WASTE WATER DISPOSAL CO.	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
RESIDUAL* INDUSTRY	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
TOTALS	73.6	74.5	79.3	87.1	139.7	175.5	191.3	200.8	172.9	151.0	83.1	73.5

NOTES:

Tabular data computed from flow measurements and laboratory analyses shown in Table 10. Tabular data represent all industrial processing wastes produced in the portion of Orange County within the Santa Ana River and San Gabriel River drainage basins.

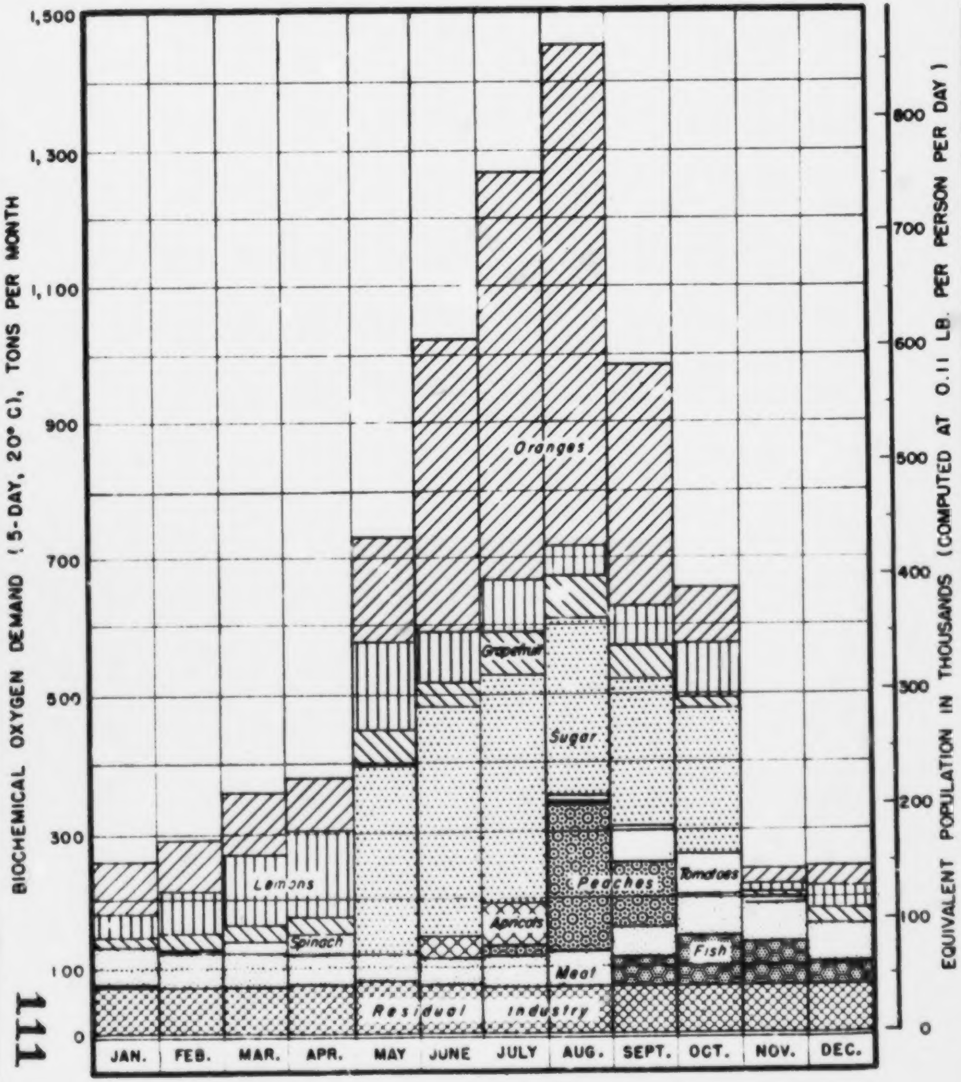
*Represents all industries other than those stated

FIGURE I

ORANGE COUNTY SEWERAGE SURVEY
BOARD OF CONSULTING ENGINEERS
CHARLES GILMAN HYDE · A M RAWN · FRANKLIN THOMAS

SEWAGE FLOW VOLUMES
FROM INDUSTRY
ORANGE COUNTY 1947

PLATE
18



PRODUCT CANNED, PROCESSED, OR MANUFACTURED	TONS PER MONTH OF B.O.D. (5-DAY, 20° C) IN INDUSTRIAL WASTES OF ORANGE COUNTY FOR 1947 (BASED ON MEASUREMENTS TAKEN IN 1946-47)											
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ORANGES	80	80	86	79	150	432	604	735	358	75	23	33
LEMONS	32	60	104	124	132	70	74	42	56	81	11	28
GRAPEFRUIT	16	23	31	30	48	38	59	68	51	16	7	25
SUGAR	0	0	0	0	282	340	336	256	214	214	0	0
TOMATOES	0	0	0	0	0	0	0	8	54	59	8	0
APRICOTS	0	0	0	0	0	31	65	1	0	0	0	0
PEACHES	0	0	0	0	0	0	14	219	90	0	0	0
SPINACH	0	6	13	30	0	0	0	0	0	0	0	0
MEAT	55	50	50	44	38	38	44	50	50	55	55	55
FISH	3	0	0	0	0	0	0	0	40	79	65	36
RESIDUAL * INDUSTRY	72	72	72	73	79	73	72	72	72	72	72	72
TOTALS	258	291	356	380	729	1,022	1,268	1,451	985	651	241	249

NOTES:

Tabular data computed from flow measurements and laboratory analyses shown in Table 10. Tabular data represent all industrial processing wastes produced in the portion of Orange County within the Santa Ana River and San Gabriel River drainage basins.

*Represents all industries other than those stated

FIGURE 2

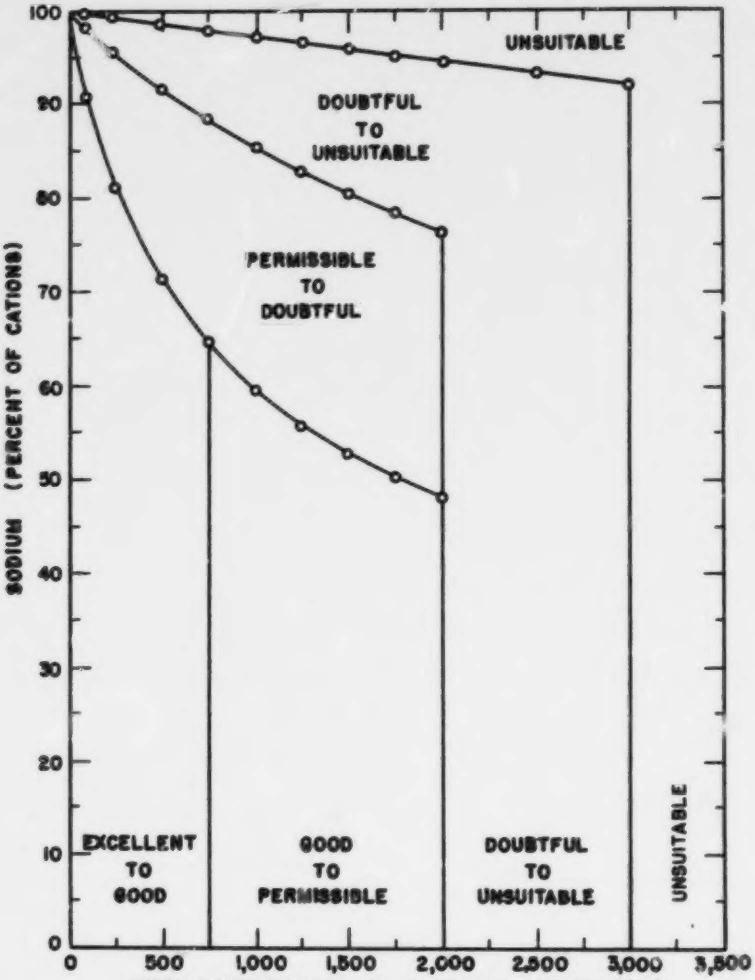
ORANGE COUNTY SEWERAGE SURVEY
BOARD OF CONSULTING ENGINEERS
CHARLES GILMAN HYDE · A M RAWN · FRANKLIN THOMAS

B. O. D. FROM INDUSTRY
ORANGE COUNTY
1947

PLATE
26

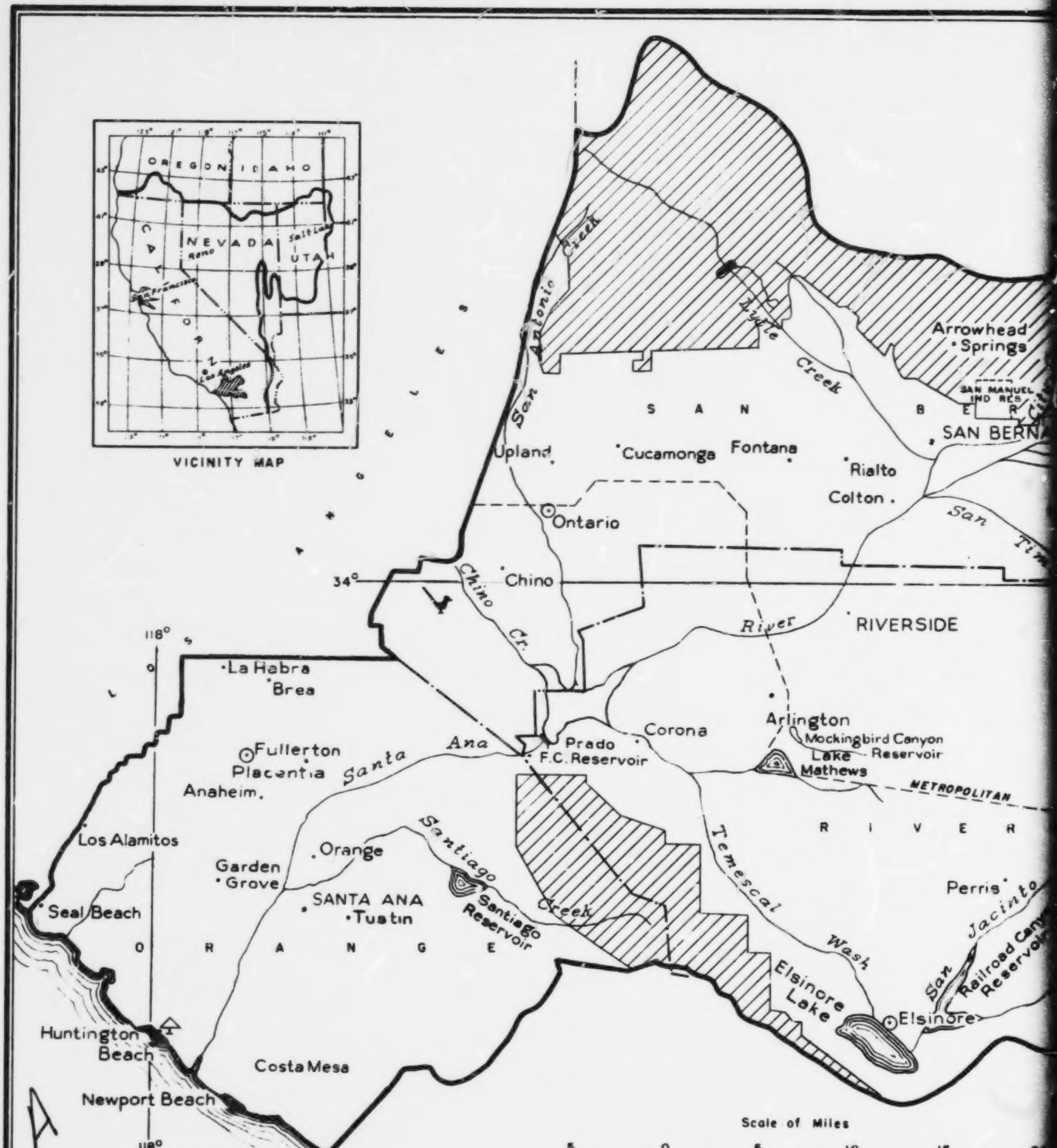
FIGURE 3

DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF AN IRRIGATION WATER



TOTAL CONCENTRATION AS ELECTRICAL CONDUCTIVITY

FROM CIRCULAR 784, U. S. DEPARTMENT OF AGRICULTURE


OREGON
IDAHO
NEVADA
UTAH
CALIFORNIA
Reno
Salt Lake
San Francisco
Los Angeles
VICINITY MAP
LOS ANGELES
SAN BERNA
ORANGE
RIVER
San Antonio Creek
Lytle Creek
Arrowhead Springs
SAN MANUEL IND RES
SAN BERNA
Upland
Cucamonga
Fontana
Rialto
Colton
San Tim
Ontario
34°
Chino
Chino Cr.
River
RIVERSIDE
118°
La Habra
Brea
Fullerton
Placentia
Anaheim
Santa Ana
Prado F.C. Reservoir
Corona
Arlington
Mockingbird Canyon Reservoir
Lake Mathews
METROPOLITAN
Los Alamitos
Garden Grove
Orange
Santiago Creek
Santiago Reservoir
SANTA ANA
Tustin
Seal Beach
Temescal Wash
Perris
San Jacinto
Railroad Canyon Reservoir
Elsinore Lake
Elsinore
Huntington Beach
Costa Mesa
Newport Beach
Scale of Miles
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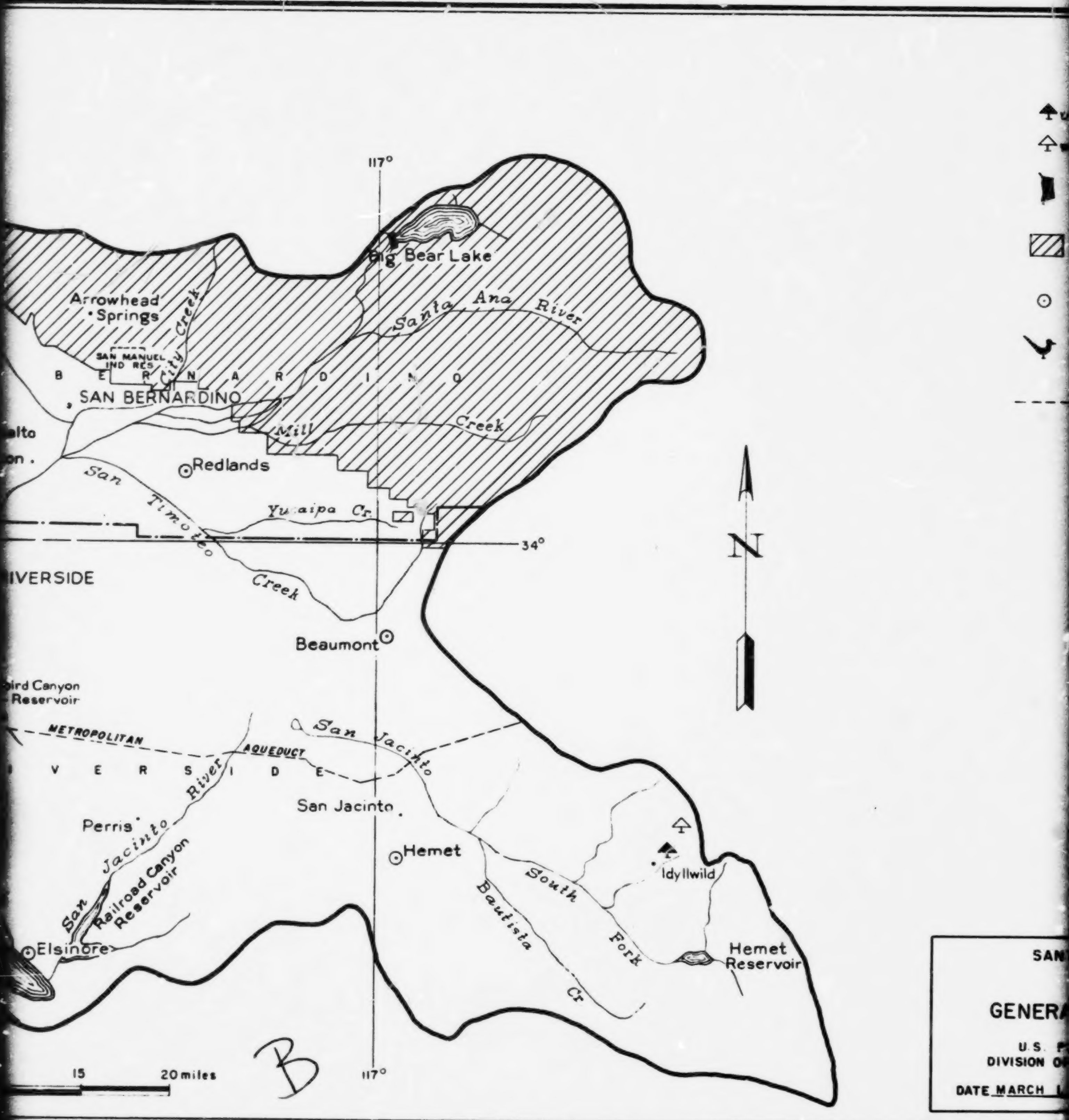
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Big Bear Lake
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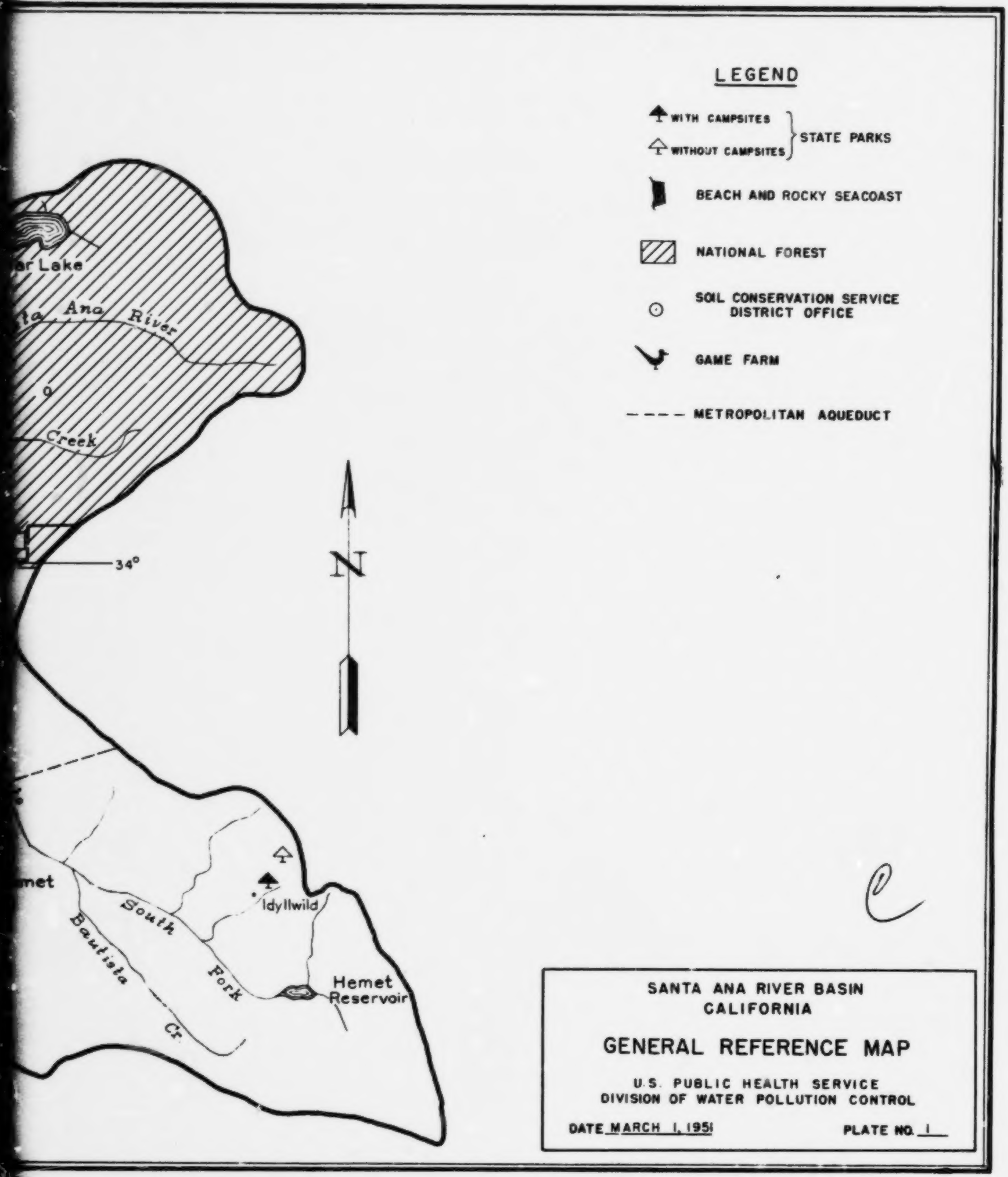
LEGEND
WITH CAMPSITES
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STATE PARKS
BEACH AND ROCKY SEACOAST
NATIONAL FOREST
SOIL CONSERVATION SERVICE DISTRICT OFFICE
GAME FARM
METROPOLITAN AQUEDUCT
ar Lake
ta Ana River
Creek
34°
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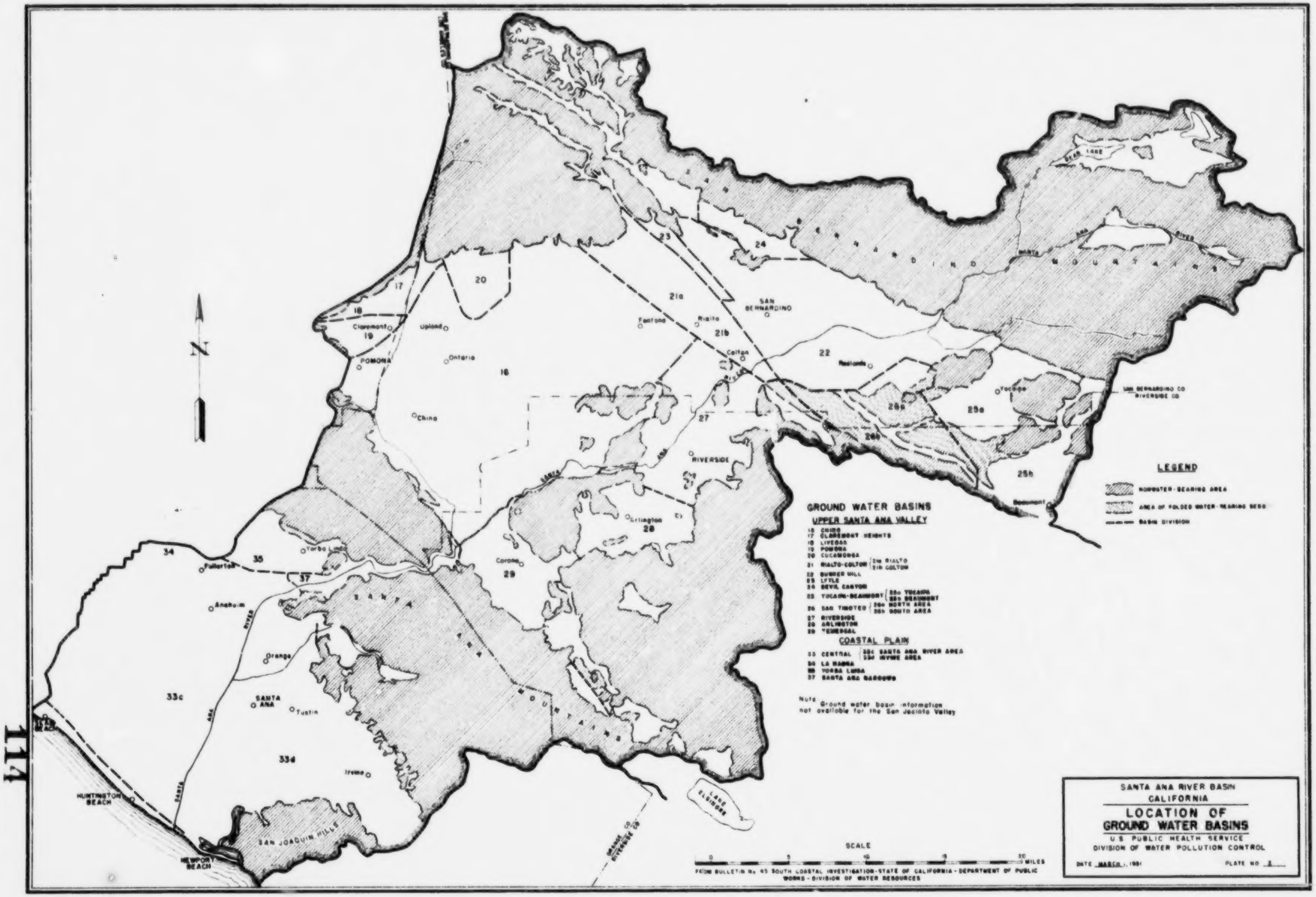
met
South Fork
Bautista Cr.
Idyllwild
Hemet Reservoir

SANTA ANA RIVER BASIN
CALIFORNIA

GENERAL REFERENCE MAP

U.S. PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH 1, 1951 PLATE NO. 1



N
SAN BERNARDINO MOUNTAINS
SANTA ANA MOUNTAINS
SAN JOAQUIN HILLS
BEAR LAKE
SANTA ANA RIVER
LAKE ELSINORE
SAN BERNARDINO CO
RIVERSIDE CO
ORANGE CO
RIVERSIDE CO
San Bernardino
Rialto
Fontana
Colton
Redlands
Yucaipa
Beaumont
Riverside
Arlington
Corona
Upland
Ontario
Claremont
Pomona
Chino
Yorba Linda
Fullerton
Anaheim
Orange
Santa Ana
Tustin
Irvine
Huntington Beach
Newport Beach
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21a
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25a
25b
26a
26b
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28
29
33c
33d
34
35
37
LEGEND
NONWATER-BEARING AREA
AREA OF FOLDED WATER-BEARING BEDS
BASIN DIVISION
GROUND WATER BASINS
UPPER SANTA ANA VALLEY
16 CHINO
17 CLAREMONT HEIGHTS
18 LIVE OAK
19 POMONA
20 CUCAMONGA
21 RIALTO-COLTON 21a RIALTO 21b COLTON
22 BUNKER HILL
23 LYTLE
24 DEVIL CANYON
25 YUCAIPA-BEAUMONT 25a YUCAIPA 25b BEAUMONT
26 SAN TIMOTEO 26a NORTH AREA 26b SOUTH AREA
27 RIVERSIDE
28 ARLINGTON
29 TEMESCAL
COASTAL PLAIN
33 CENTRAL 33c SANTA ANA RIVER AREA 33d IRVINE AREA
34 LA HABRA
35 YORBA LINDA
37 SANTA ANA NARROWS
SCALE
0
5
10
15
20
MILES

Note Ground water basin information not available for the San Jacinto Valley

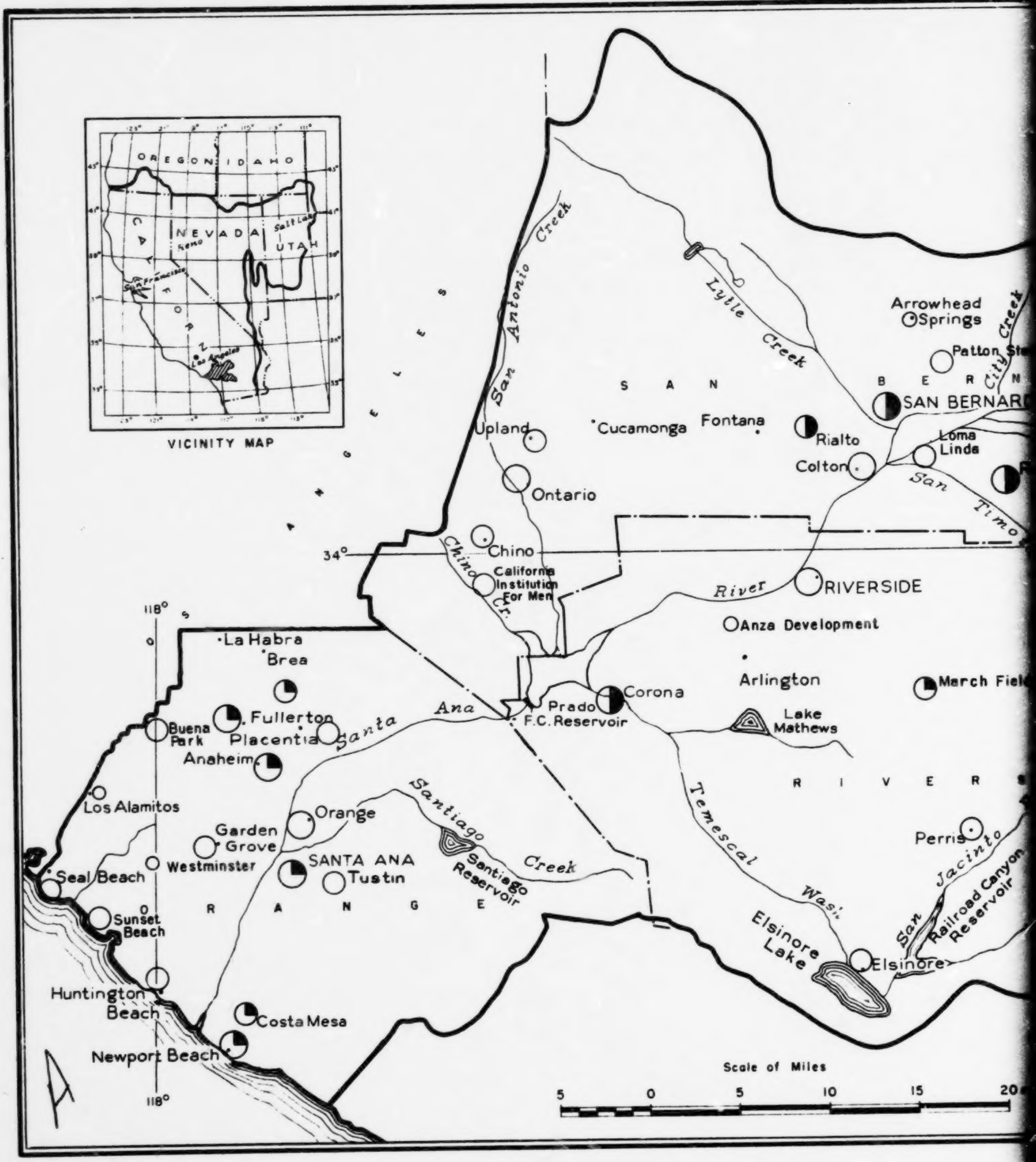
FROM BULLETIN No. 45 SOUTH COASTAL INVESTIGATION-STATE OF CALIFORNIA-DEPARTMENT OF PUBLIC WORKS-DIVISION OF WATER RESOURCES

SANTA ANA RIVER BASIN
CALIFORNIA

LOCATION OF
GROUND WATER BASINS

U S PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH, 1961
PLATE NO. 3


VICINITY MAP
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San Antonio Creek
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City Creek
Arrowhead Springs
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Prado
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Corona
Lake Mathews
La Habra
Brea
Fullerton
Buena Park
Placentia
Santa Ana
Anaheim
Los Alamitos
Orange
Garden Grove
Westminster
SANTA ANA
Tustin
Santiago Creek
Santiago Reservoir
Temescal Wash
Perris
San Jacinto
Railroad Canyon Reservoir
Elsinore Lake
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Newport Beach
Scale of Miles
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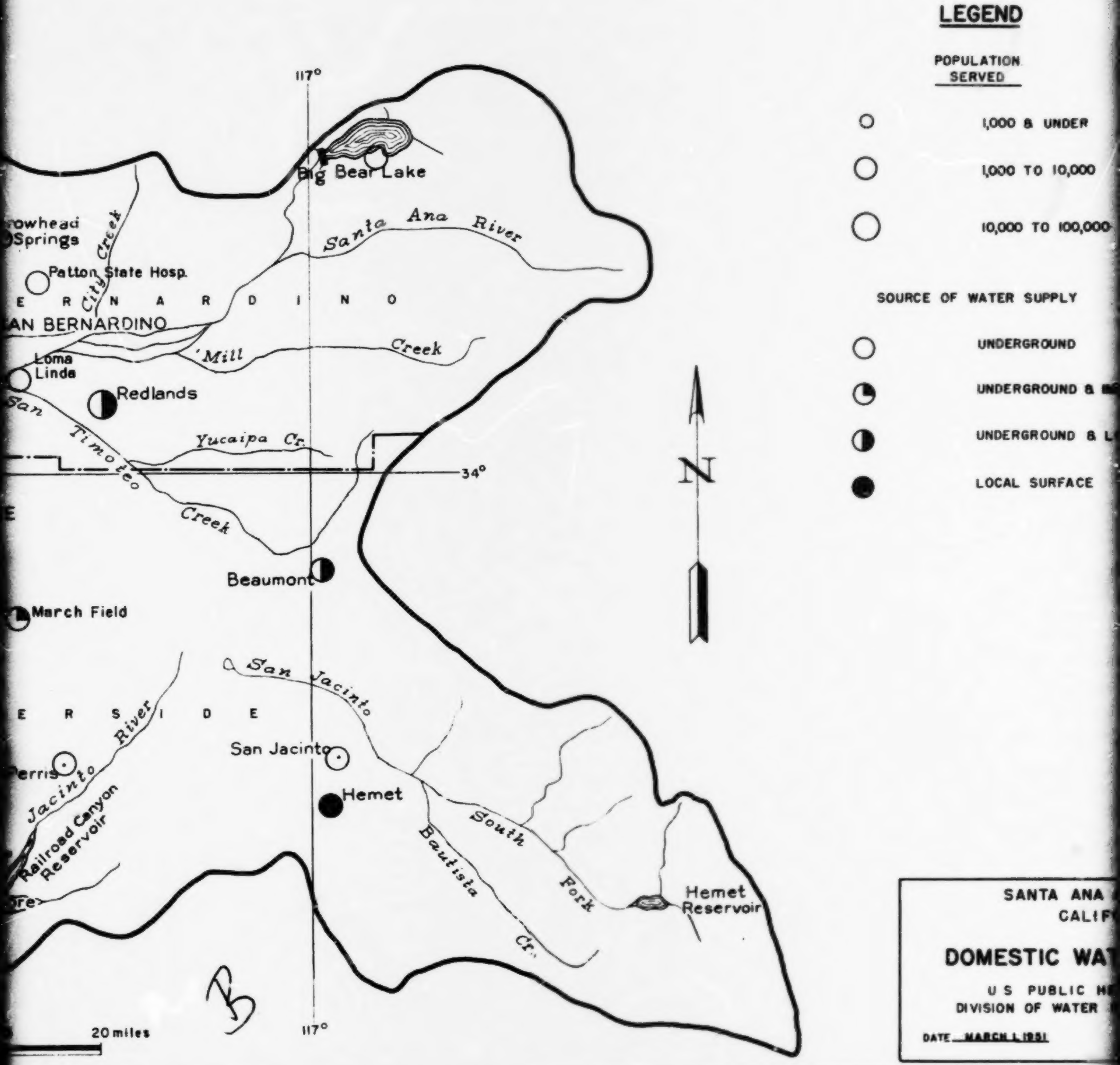
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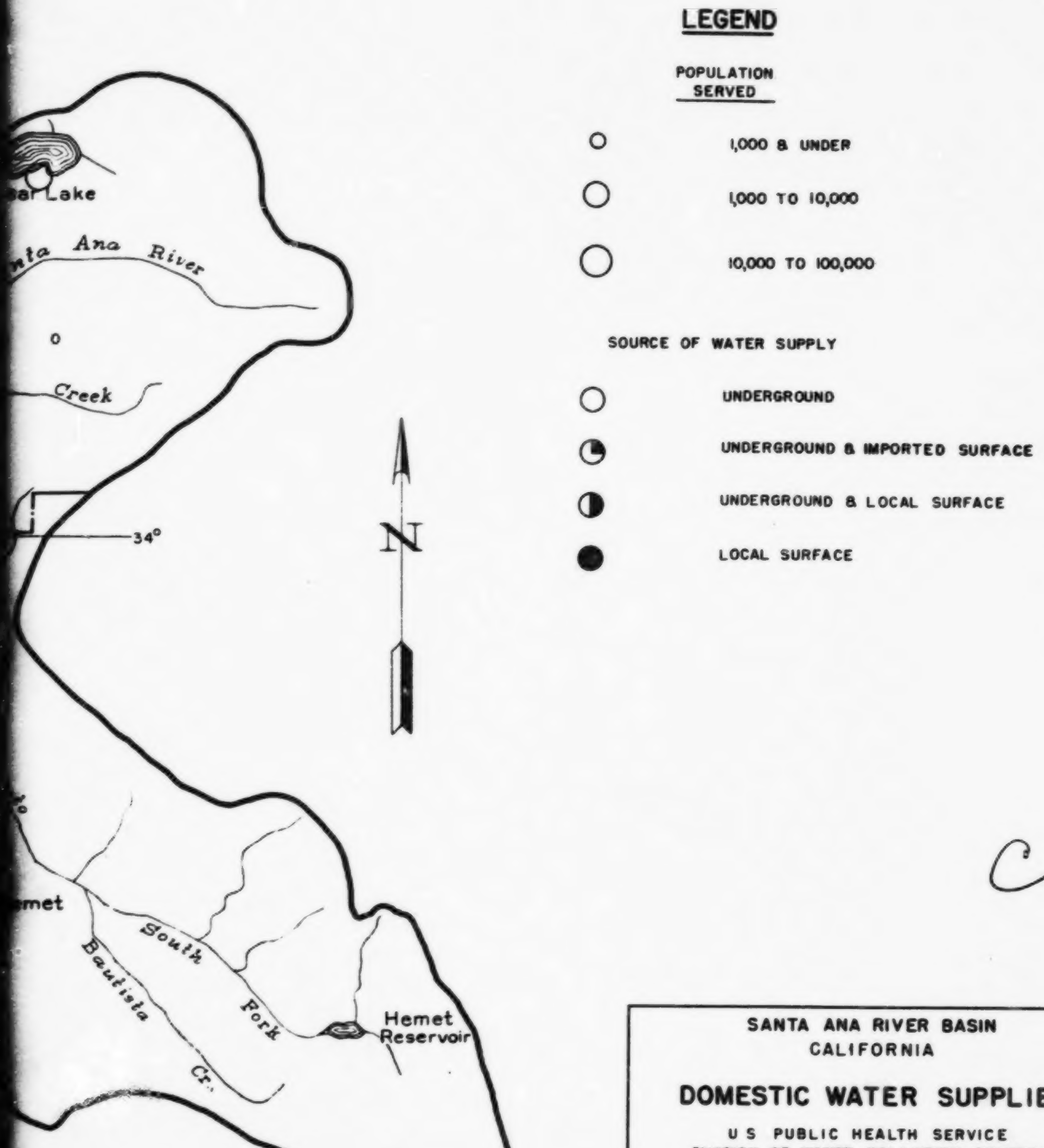
DATE MARCH 1, 1951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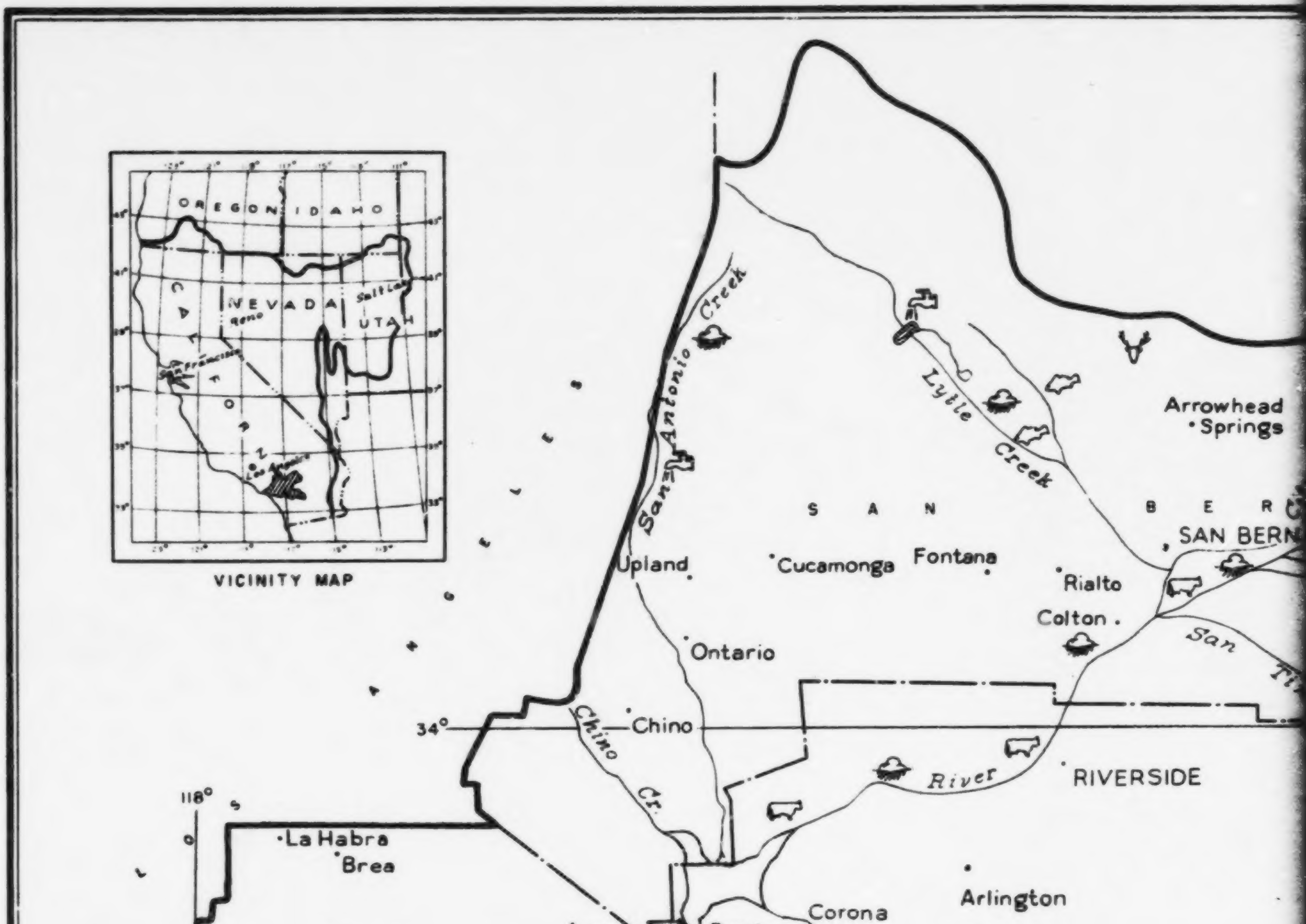
SANTA ANA RIVER BASIN
CALIFORNIA

DOMESTIC WATER SUPPLIES

U S PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH 1, 1951 PLATE NO. 3


VICINITY MAP
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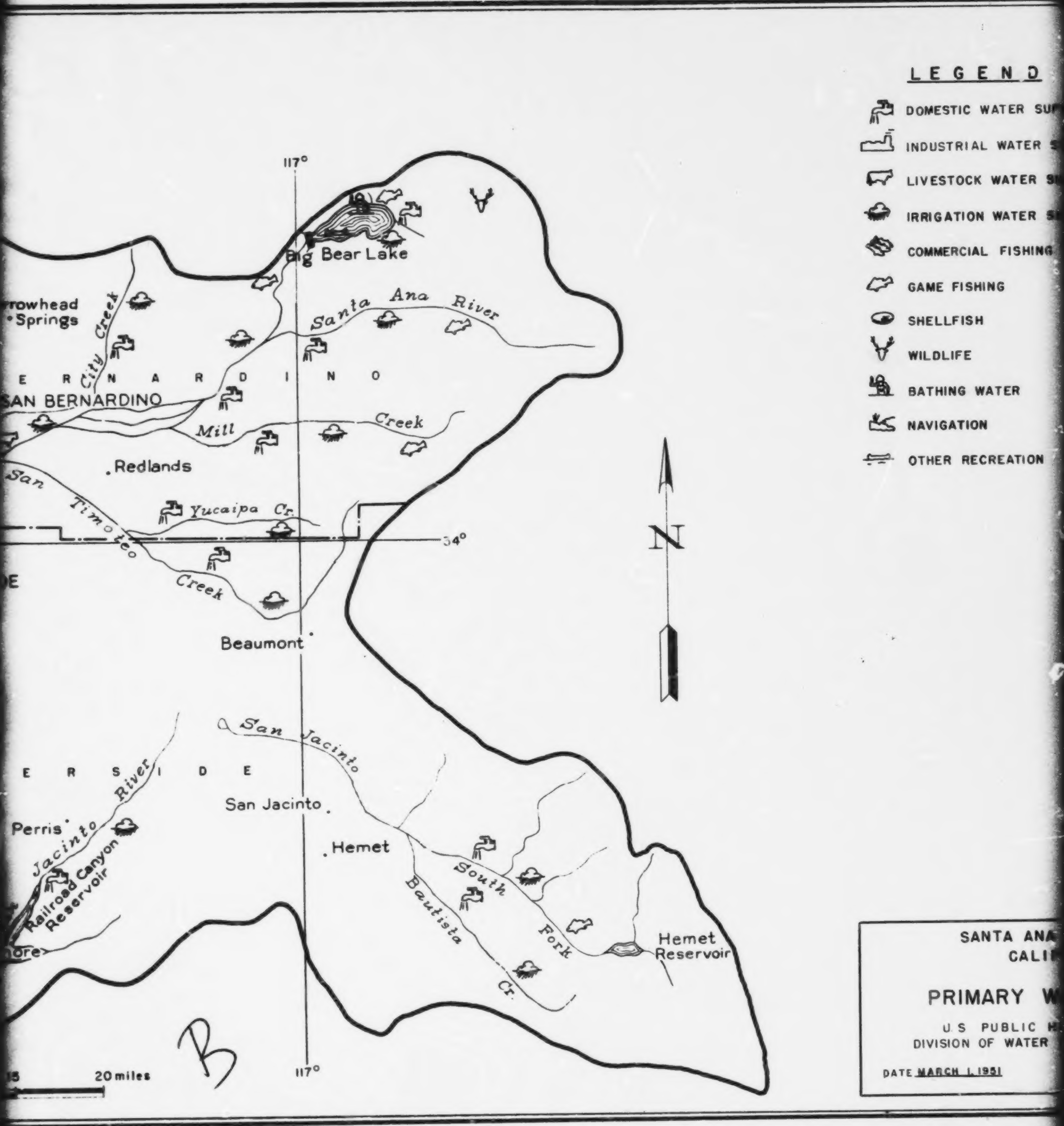
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SANTA ANA
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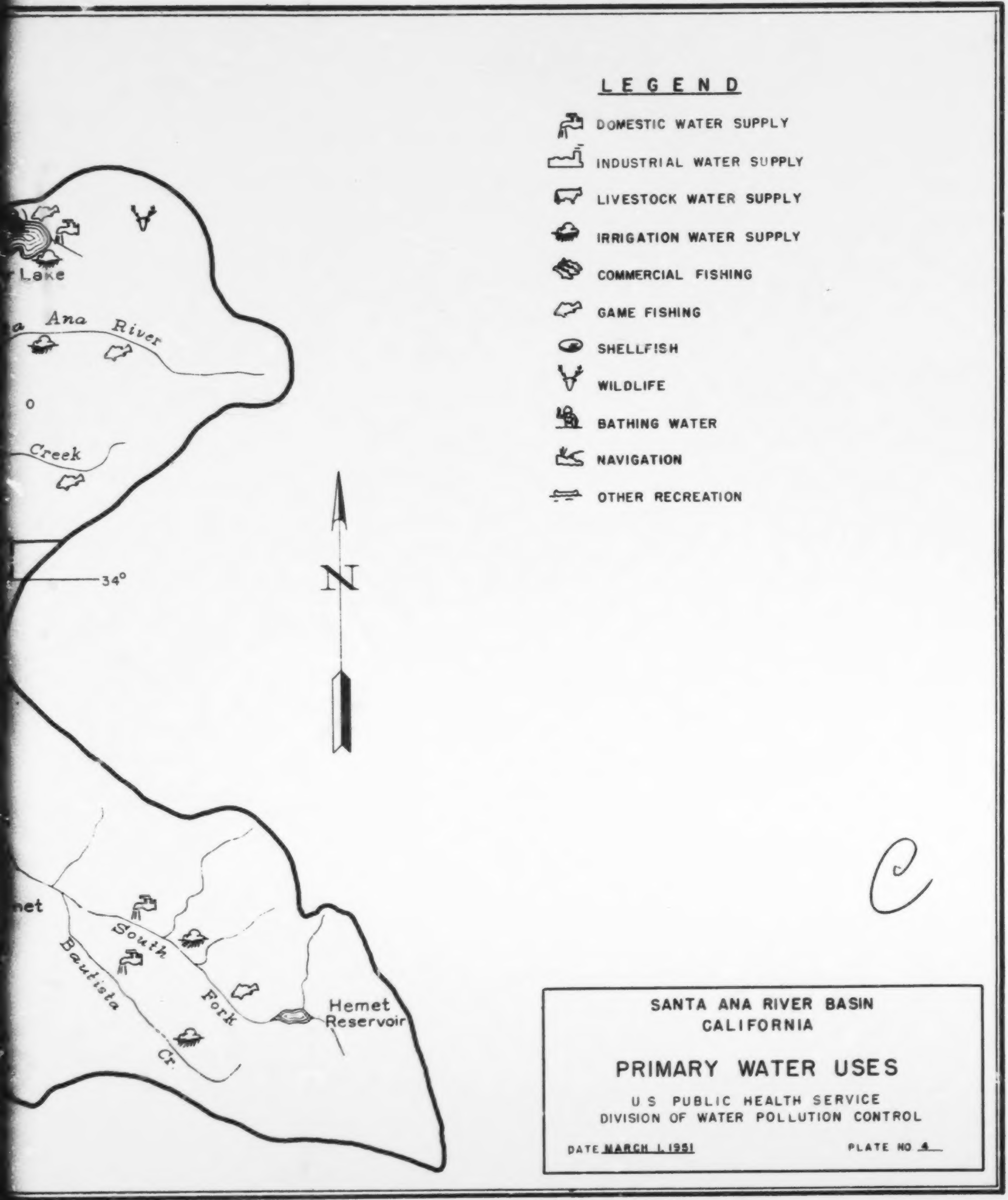
DATE MARCH 1, 1951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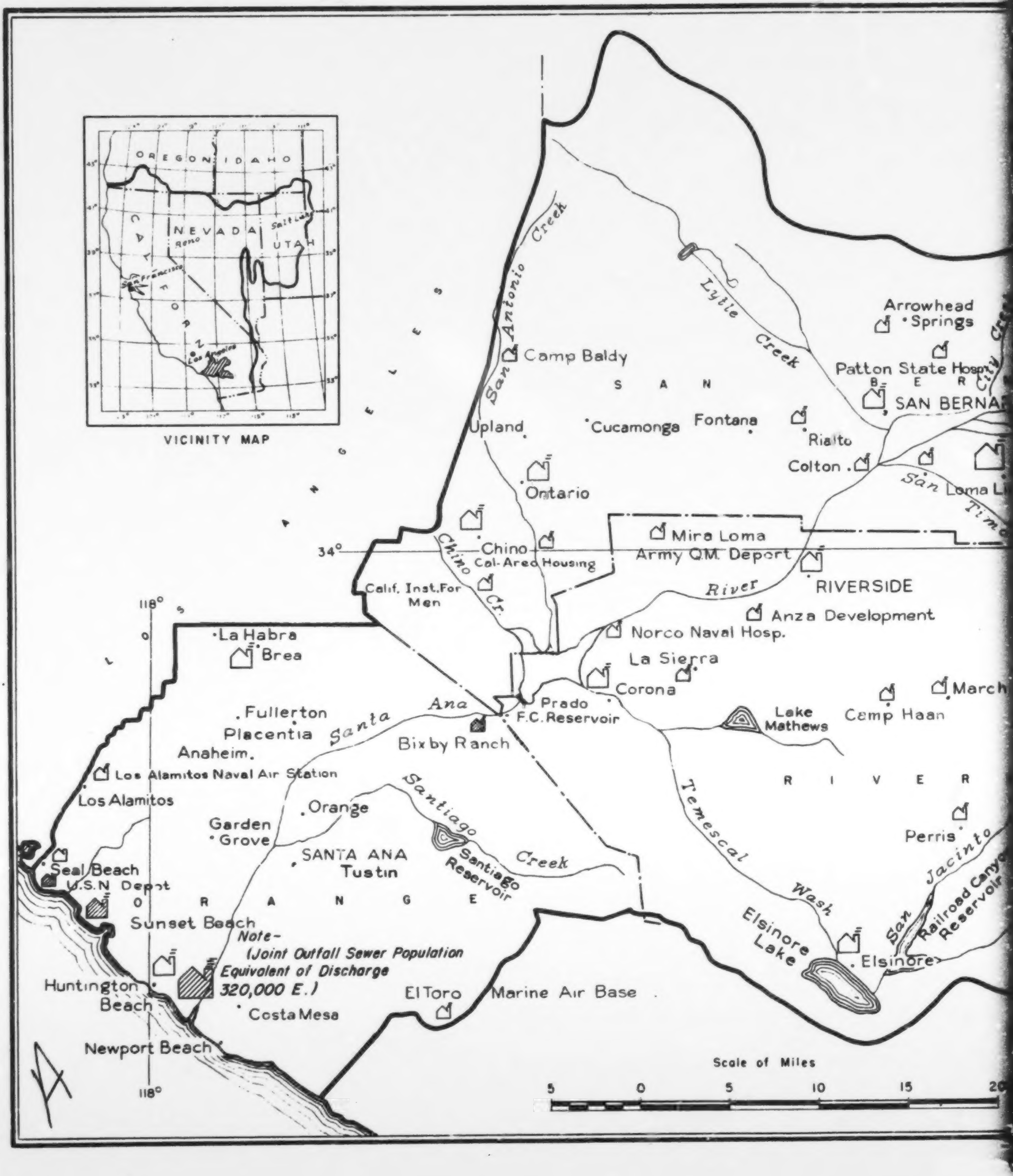
SANTA ANA RIVER BASIN
CALIFORNIA

PRIMARY WATER USES

U S PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH 1, 1951 PLATE NO 4

C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San Antonio Creek
Lytle Creek
City Creek
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Cal-Area Housing
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Chino Cr.
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Anza Development
Norco Naval Hosp.
La Sierra
Corona
La Habra
Brea
Prado F.C. Reservoir
Lake Mathews
Camp Haan
March
Fullerton
Placentia
Anaheim
Santa Ana
Bixby Ranch
Los Alamitos Naval Air Station
Los Alamitos
Garden Grove
Orange
Santiago Creek
Santiago Reservoir
Temescal Wash
Perris
San Jacinto
Railroad Canyon Reservoir
Seal Beach
U.S.N. Depot
SANTA ANA
Tustin
Sunset Beach
Elsinore Lake
Elsinore
Huntington Beach
Costa Mesa
El Toro Marine Air Base
Newport Beach
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Note-
(Joint Outfall Sewer Population
Equivalent of Discharge
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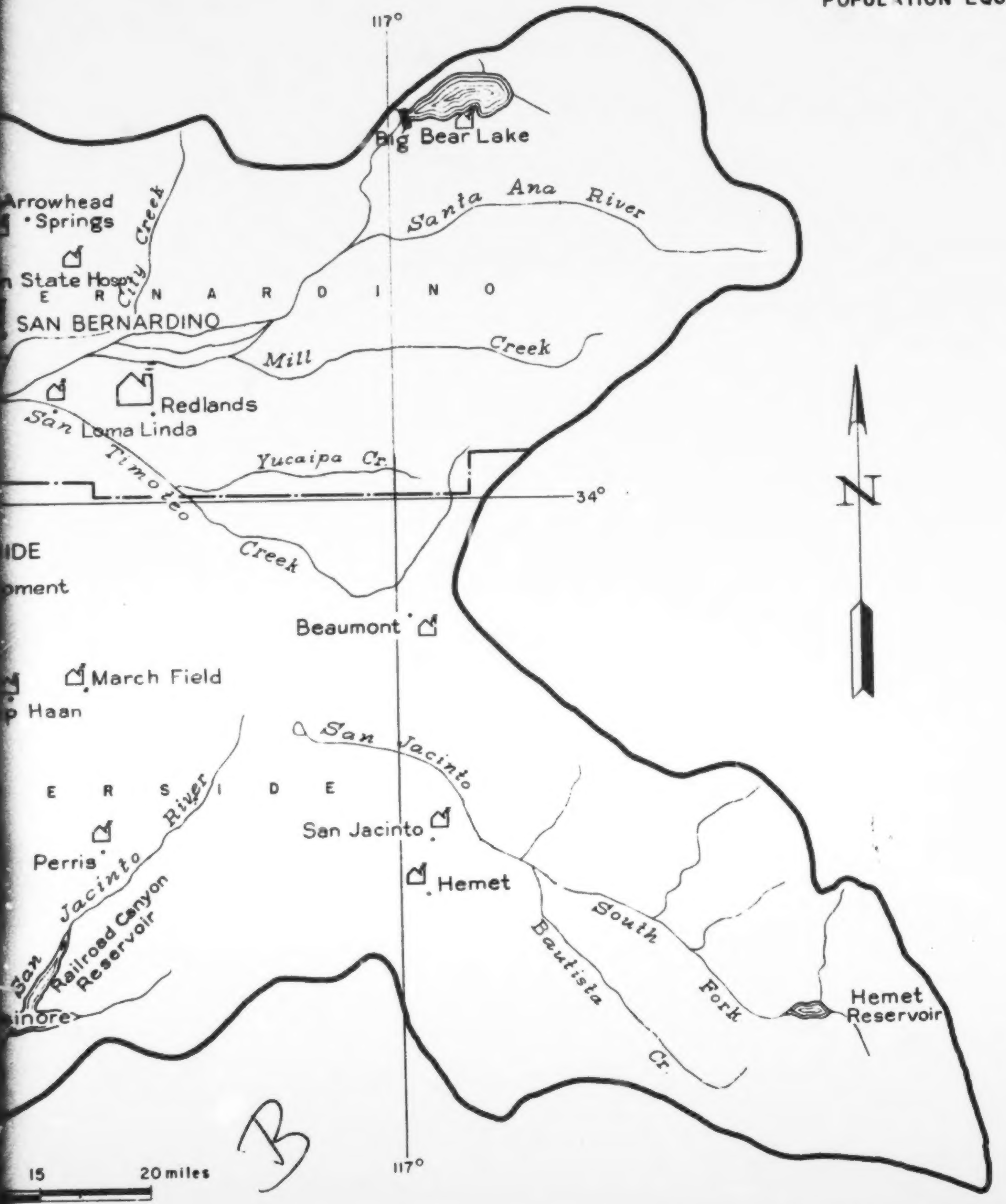
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L E G E N D

SOURCES OF MUNICIPAL POLLUT

POPULATION EQUIVALENT (B.O.D.) OF WASTES AS

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- 5,000 – 20,000
- 20,000 – OVER

EXISTING TREATMENT FAC

- ☐ SECONDARY
- ▨ PRIMARY

NOTE—

"Primary Treatme
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SANTA ANA
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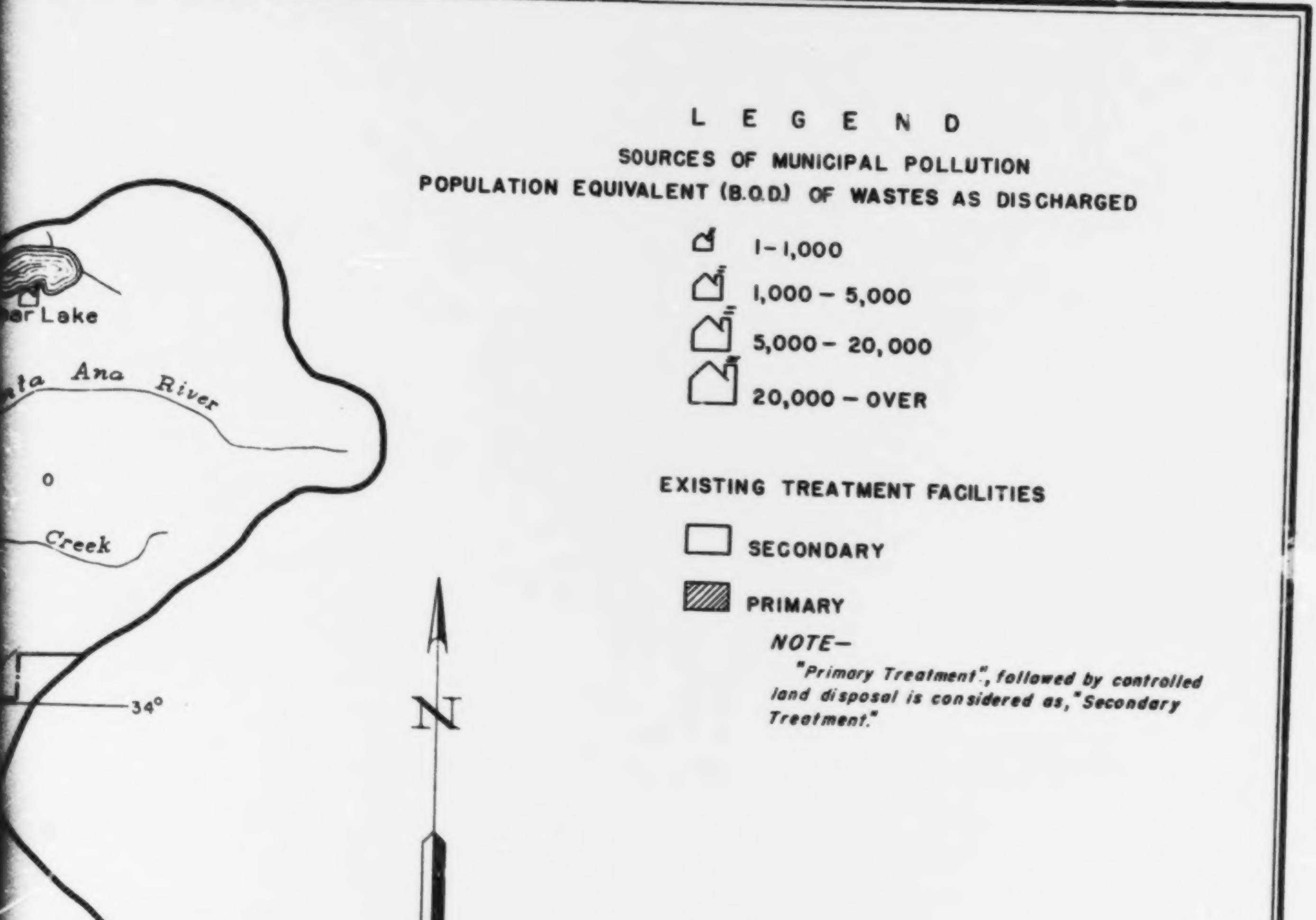
U.S. PUBLIC
DIVISION OF WATER

DATE MARCH 1, 1951


LEGEND
SOURCES OF MUNICIPAL POLLUTION
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5,000 - 20,000
20,000 - OVER
EXISTING TREATMENT FACILITIES
SECONDARY
PRIMARY
NOTE—
"Primary Treatment", followed by controlled land disposal is considered as, "Secondary Treatment."
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nta Ana River
Creek
met
South Fork
Bautista Cr.
Hemet Reservoir

C

SANTA ANA RIVER BASIN
CALIFORNIA

SOURCES OF MUNICIPAL POLLUTION AND EXISTING TREATMENT FACILITIES

U.S. PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH 1, 1951

PLATE NO. 3

Key to Plate 6

Wineries in the Santa Ana River Basin of California

Firm Name	Location		Type of Plant
Jim Abbona	Chino,	San Bernardino Co.	Bonded Winery
Formerly BW 4333 of Assoc. Enterprise	Ontario,	" " "	" "
Audenino Winery	"	" " "	" "
Avalon Winery	Cucamonga,	" " "	" "
Big Bear Winery	"	" " "	" "
Joe Cangemi & Son	Ontario,	" " "	" "
Eugene Charpin	Fontana,	" " "	" "
Coppo Winery	Mira Loma,	" " "	Bonded Winery & Distillery
Cucamonga Growers Co-Operative Winery	Ontario,	" " "	" " " "
Cucamonga Pioneer Vineyard Association	Cucamonga,	" " "	" " " "
Cucamonga Valley Wine Co.	Ontario,	" " "	" " " "
Cucamonga Winery	Cucamonga,	" " "	Bonded Winery
Etivista Winery & Vineyards	"	" " "	Bonded Winery & Distillery
Claremont Vintners & Distillers	Claremont,	" " "	" " " "
Ellena Brothers	Etiwanda,	" " "	" " " "
Etiwanda Grape Products Co.	"	" " "	" " " "
J. Filippi Vintage Co.	Mira Loma,	" " "	Bonded Winery
Fountain Winery	Ontario,	" " "	" "
Fruit Industries, Ltd.	Guasti,	" " "	" "
Garrett & Company, Inc.	Cucamonga,	" " "	Bonded Winery & Distillery
F. C. Haberstroh Winery	Etiwanda,	" " "	Bonded Winery
Highland Wine-Growers, Inc.	Cucamonga,	" " "	" "
Garrett & Company, Inc.	Guasti,	" " "	Bonded Winery & Distillery
Mrs. Marie Liabeuf	Fontana,	" " "	Bonded Winery
Lytle Creek Winery	Fontana,	" " "	" "
Masi Brothers	Cucamonga,	" " "	" "
Yakov Mornarich Winery	Fontana,	" " "	" "
Padre Vineyard Company	Cucamonga,	" " "	Bonded Winery & Distillery

Firm Name	Location	Type of Plant
Formerly BW 3711 of Nicolas Pica	Ontario, San Bernardino Co.	Bonded Winery
Romolo Winery	Cucamonga, " " "	" "
Sanchez Winery	" " " "	Bonded Winery & Distillery
Formerly BW 3513 and FD 502 of Santa Anita Vineyards	" " " "	" " " "
Formerly FD 81 of The Schluter Corp.	Colton, " " "	" " " "
Formerly BW 3927 of Many, Blanc & Co.,Inc.	" " " "	Bonded Winery
Cucamonga Top Winery	Cucamonga, " " "	" "
Olbert & Son	Highland, " " "	" "
Capistrano Winery & Vineyards Co.	Fontana, " " "	Bonded Winery & Distillery
Louis Cherpin Winery	" " " "	Bonded Winery
Cucamonga Central Winery	Ontario, " " "	" "
California Wines, Ltd.	Alta Loma, " " "	" "
Cucamonga Winery	Cucamonga, " " "	Bonded Wine Storeroom
Santa Fe Vintage Company	Bloomington," " "	" " "
Thomas Vineyards	Cucamonga, " " "	" " "
Schuster Distillery	Colton, " " "	Grain Distillery
Domenico Gallesno	Riverside, Riverside Co.	Bonded Winery
Antonion Filippi	Mira Loma, " "	Bonded Winery & Distillery
Marietta Winery	" " " "	" " " "
Opica Winery	" " " "	Bonded Winery
Riverside County Line Winery	Ontario, " "	" "
Rubidoux Winery	Riverside, " "	Bonded Winery & Distillery

Food Processing Plants in the Santa Ana River Basin

Firm Name	Location	Waste Disposal
Anaheim Citrus Products	Anaheim, Orange Co.	Orange County Joint Outfall Sewer
California Citrus Processors	" " "	"
E. A. Silzle Corporation	" " "	"
Mutual Citrus Products Company	" " "	"
Alcohol Plant	" " "	"
Brined Fruit Co. of Southern California	Brea, Orange Co.	Not Operating in 1950
Harts Citrus Juice Company	" " "	Brea City sewage treatment plant
Glidden Company	Buena Park, Orange Co.	Unknown
Knotts Berry Place	" " " "	Septic tank, subsurface irrigation
Uddo & Toarmina Company	" " " "	Irrigation
Maddox Pickle Plant	Chino, Riverside Co.	Unknown
Walnut Growers Packing Plant	" " "	"
California Citrus Pulp Co.	Colton, San Bernardino Co.	Colton City sewer and to land
Citrus By-products Plant	" " " "	Unknown
Pliny Cross Slaughter House	" " " "	Land
Smith Slaughter House	" " " "	Unknown
Exchange Lemon Products	Corona, Riverside Co.	Lagoons & percolation beds
Fontana Farms Company Hog Ranch	Fontana, San Bernardino Co.	Land
Swift Duckling Farm (near Fontana)	" " " "	"
Caltone Corporation	Fullerton, Orange Co.	Orange County Joint Outfall Sewer
Hunts Foods, Inc.	" " "	"
Pacific Citrus Products Co.	" " "	"
Miller Bros. Co.	Garden Grove, Orange Co.	Unknown
California Cooperative Cannery	Hemet, Riverside Co.	"
Hemet Packing Company	" " "	"

Page 3, Key to Plate 6

Firm Name	Location	Waste Disposal
Loma Linda Food Plant	La Sierra Heights, Riverside Co.	Irrigated pasture
California Fruit Grower's Exchange	Ontario, San Bernardino Co.	Unknown
C. C. Graber Co.	" " " "	"
Marino-Ontario Olive Company	" " " "	"
Old Ranches Olive Company	" " " "	"
Exchange Orange Products Company	" " " "	Fine screens, 240 acres of land
Ontario Fertilizer Company	" " " "	Unknown
Natural Food Products Company	Orange, Orange Co.	Orange County Joint Outfall Sewer
Santa Anita Packing Company	" " "	Not operating in 1950
Citrus Juice & Flavor Co., Ltd.	" " "	Orange County Joint Outfall Sewer
F. A. Kimball	Redlands, San Bernardino Co.	Unknown
Southern California Citrus Foods	" " " "	"
Sieck Slaughter House	Riverside, Riverside Co.	Land
T. & J. Slaughter House	" " "	Percolation beds in stream bed
Del Rosa Packing Plant	San Bernardino, San Bernardino Co.	To dry watercourse
Cal-Compack Foods, Inc.	Santa Ana, Orange Co.	Unknown
Case-Swayne Company	" " " "	Orange County Joint Outfall Sewer
Pure Citrus Juice Co.	" " " "	Septic tank
Sierra Frozen Foods	" " " "	Orange County Joint Outfall Sewer
Tree Sweet Products Co.	" " " "	"
Holly Sugar Company	" " " "	Fine Screens, sedimentation, irrigation
Utt Juice Company	Tustin, Orange Co.	Land
K & R Fruit Products, Inc.	Upland, San Bernardino Co.	Dry wash

Plants with Inorganic Wastes in the Santa Ana River Basin

Firm Name	Location	Waste Disposal
California Portland Cement Co.	Colton, San Bernardino Co.	Santa Ana River
Western Tank Car Company	" " " "	Oil separation, evaporation of sodium salts, neutralization of acid, percolation
Aluminum and Magnesium, Inc.	Near Corona, Riverside Co.	Slag hauled to desert
Minnesota Mining & Mfg. Co.	" " " "	Temescal wash
Kaiser Steel Corporation	Fontana, San Bernardino Co.	Slag quenching; percolation
*Huntington Beach Oil Field	Huntington Beach, Orange Co.	Some to ocean & some to land
El Toro Marine Base	El Toro, Orange Co.	San Diego Creek
*Murphy-Coyote Lease-Oilfield	Orange Co.	Santa Fe Springs Waste Water Disposal Co.
*West Newport Beach Oil Field	Newport Beach, Orange Co.	Talbert Drainage Ditch - ocean
General Electric Corporation	Ontario, San Bernardino Co.	Chromic acid wastes trucked to Anaheim
Waste Water Disposal Company	Fullerton, Orange Co.	Orange County Joint Outfall Sewer
*Carbon Canyon, Fullerton Dam Area Oil Field	Orange County	Waste Water Disposal Co. & percolation
*Richfield, Yorba Linda, Atwood Area Oil Field	" "	" " " " " "
Revere Ware Plant	Riverside, Riverside Co.	Neutralize acid
Hunter Douglas Co.	" " "	Trucked to L.A. Co. system
Culligan Zeolite Co.	San Bernardino, San Bernardino Co.	Percolation beds
Norton Air Force Base	" " " " "	" "
Dow Chemical Co.	Seal Beach, Orange Co.	Tidal waters of San Gabriel River
Los Angeles Bureau of Water and Power Seal Beach Steam Plant	" " " "	" " " " " "
Santa Fe Springs Waste Water Disposal Co.	" " " "	" " " " " "

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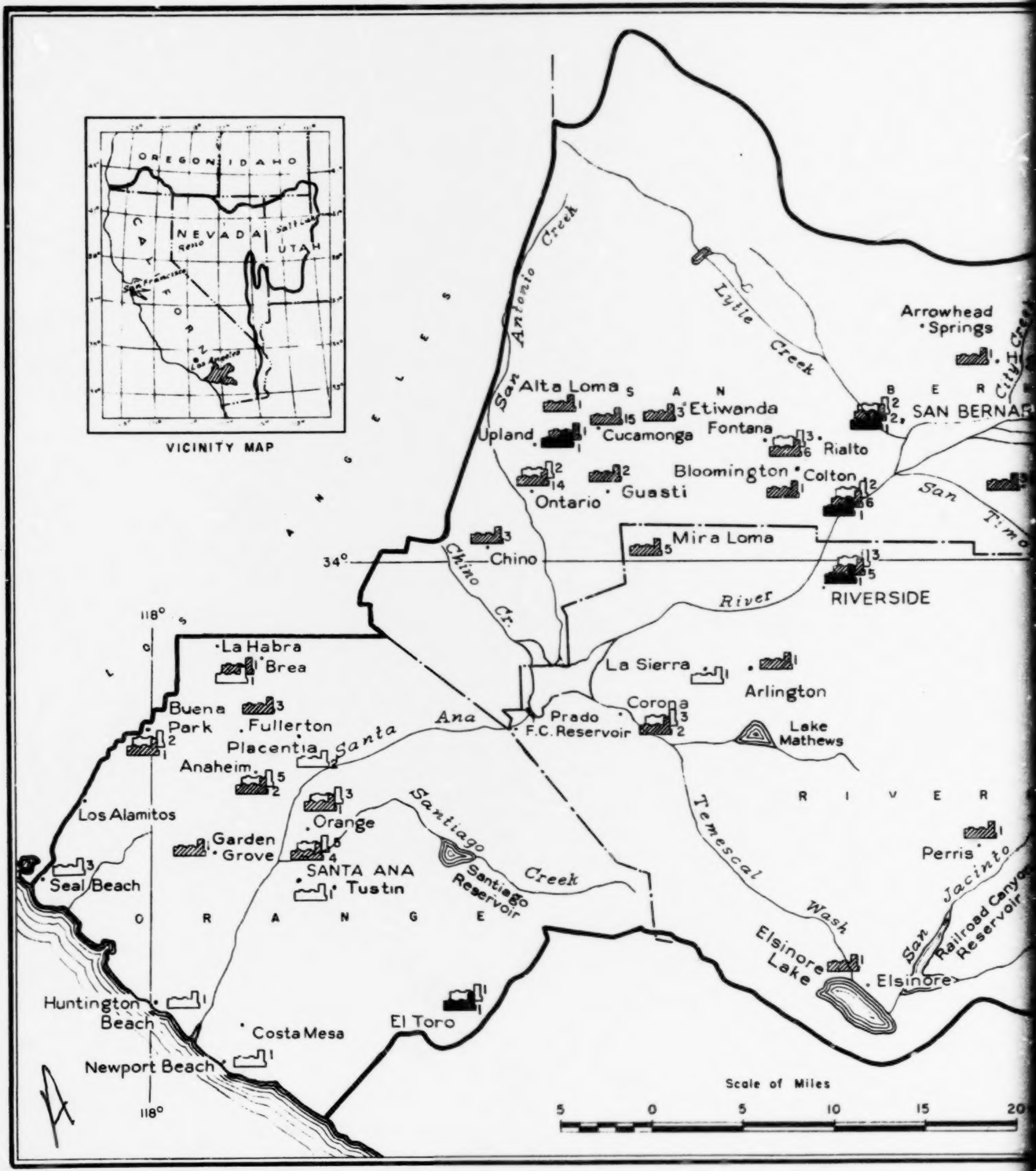
* The eight major oil producing areas have been grouped into five fields to agree with the discussion in Exhibit I.

Page 5, Key to Plate 6

Milk Products Plants in the Santa Ana River Basin

Firm Name	Location	Waste Disposal
Golden Crest Dairy	Anaheim, Orange Co.	Unknown
Yellis Dairy	" " "	"
Teunissen Dairy	Arlington, Riverside Co.	"
Grandview Creamery Co.	Corona, Riverside Co.	"
Sanitary Dairy	" " "	"
Lakeview Dairy	Elsinore, " "	"
Idyllwild Dairy	Idyllwild, " "	"
Perfection Dairy	Perris, " "	"
Brookside Dairy	Redlands, San Bernardino Co.	"
Blue Bird Dairy	Riverside, Riverside Co.	"
Carnation of California	" " "	"
Orange Crest Dairy	" " "	"
Big Bear Creamery	San Bernardino, San Bernardino Co.	"
Blue Ribbon Dairy	" " " " "	"
San Jacinto Dairy	San Jacinto, Riverside Co.	"
Colonial Dairy	Santa Ana, Orange Co.	"
Excelsior Creamery Co., Ltd.	" " " "	"
Todd's Dairy	" " " "	"
Allura Farm Dairy	Upland, San Bernardino Co.	"

Page 6, Key to Plate 6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Los Alamitos
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Costa Mesa
Newport Beach
El Toro
Santiago Reservoir
Prado F.C. Reservoir
La Sierra
Arlington
Corona
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Scale of Miles
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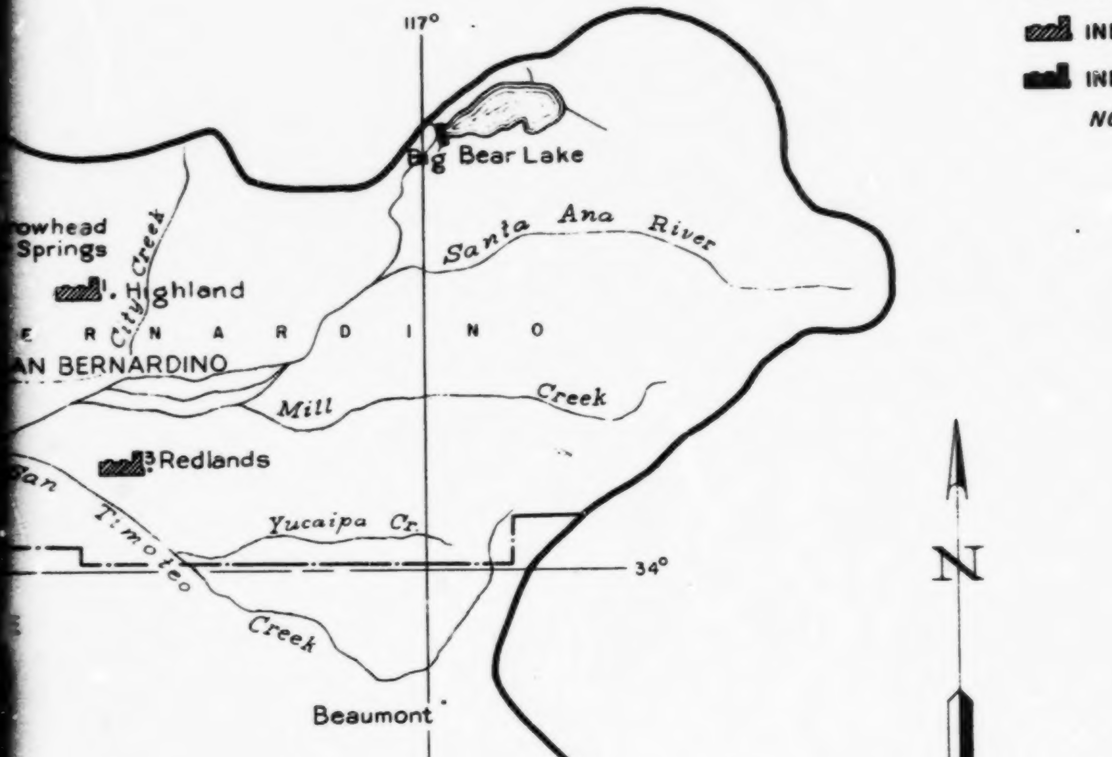
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Big Bear Lake
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San Timoteo Creek
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Bautista Cr.
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Hemet Reservoir
Railroad Canyon Reservoir
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▭ INDUSTRIES WITH TREATMENT FACIL

▨ INDUSTRIES WITH TREATMENT FACIL

■ INDUSTRIES WITH NO TREATMENT

NOTE-

Numbers Appearing By Symbols Indi
Of Industrial Pollution Sources In The
Category Designated.

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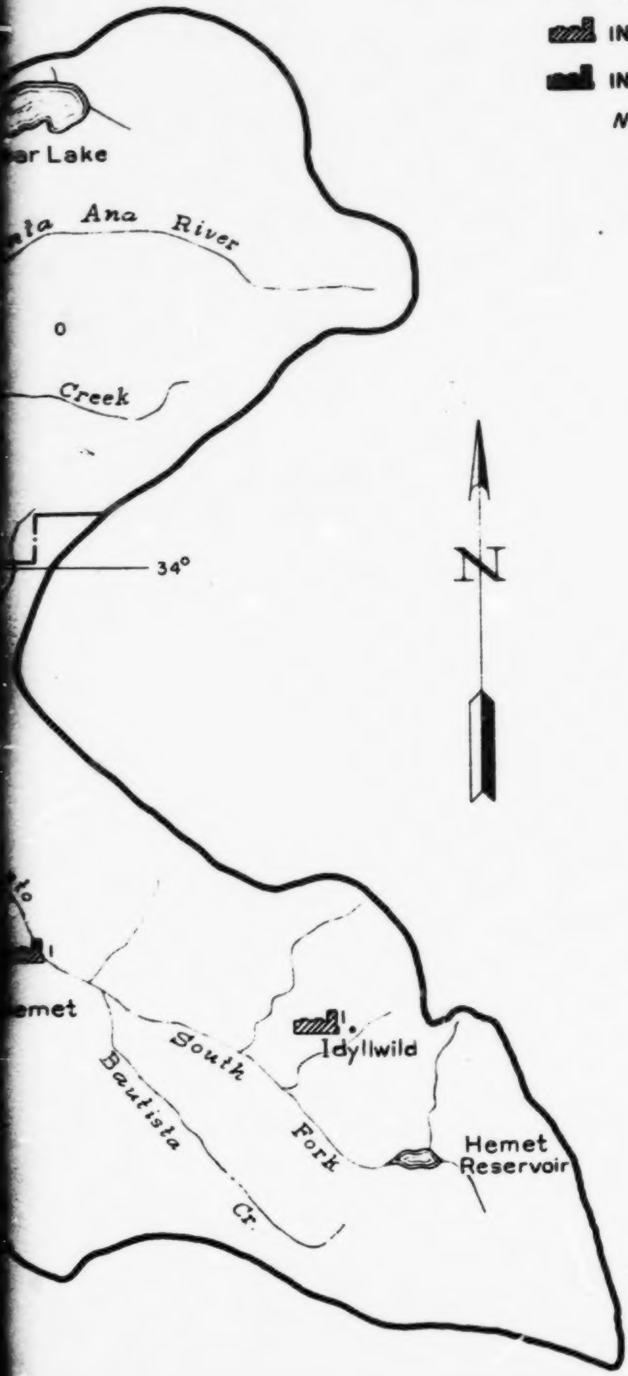
DATE MARCH 1, 1951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Idyllwild
South Fork
Bautista Cr.
Hemet Reservoir

L E G E N D

- ☐ INDUSTRIES WITH TREATMENT FACILITIES
- ▨ INDUSTRIES WITH TREATMENT FACILITIES UNDETERMINED
- ■ INDUSTRIES WITH NO TREATMENT

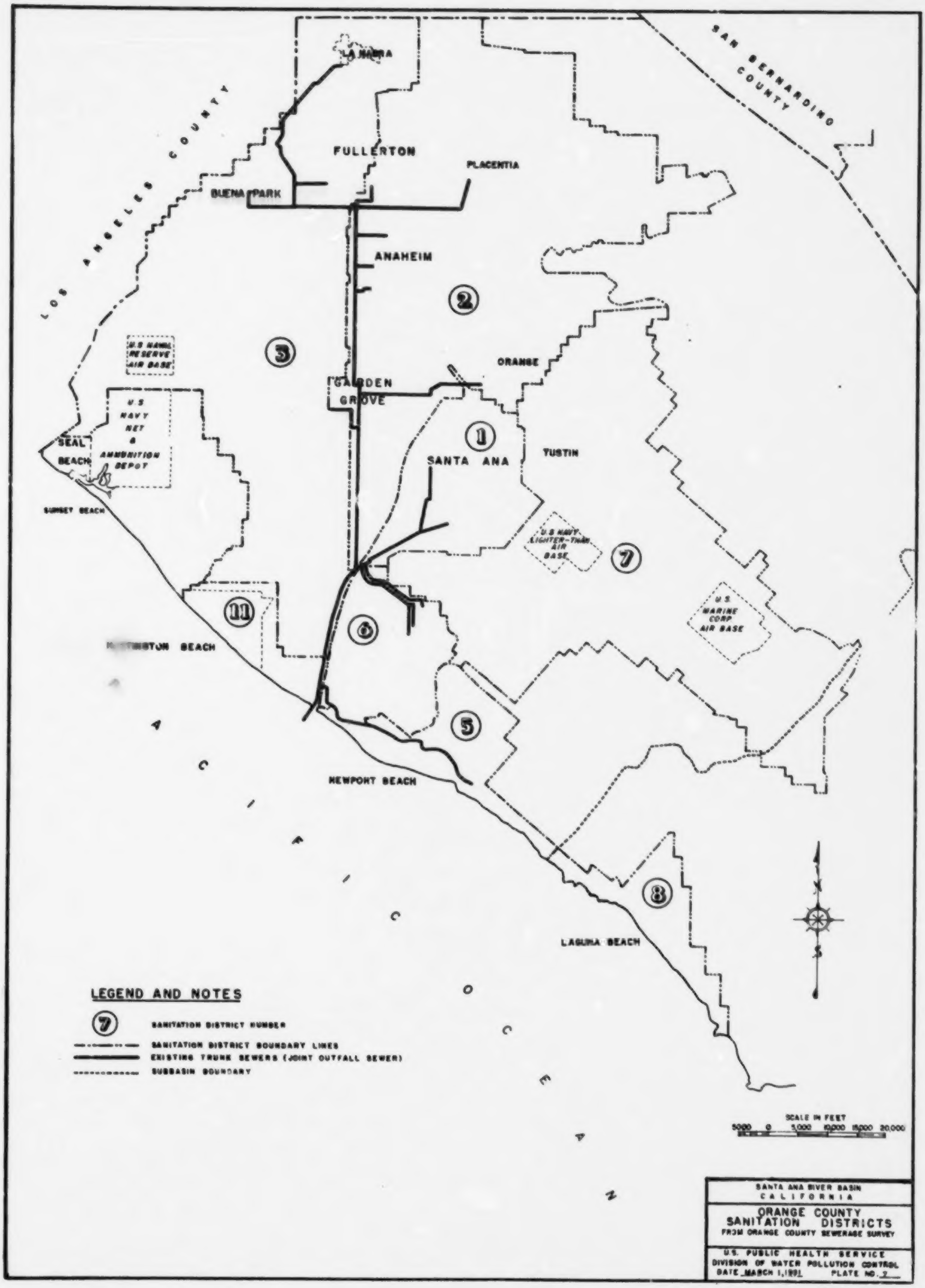
NOTE–

Numbers Appearing By Symbols Indicate Total Number Of Industrial Pollution Sources In The Area In The Category Designated.

C

SANTA ANA RIVER BASIN
CALIFORNIA
SOURCES OF INDUSTRIAL POLLUTION
AND EXISTING TREATMENT FACILITIES
U.S. PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

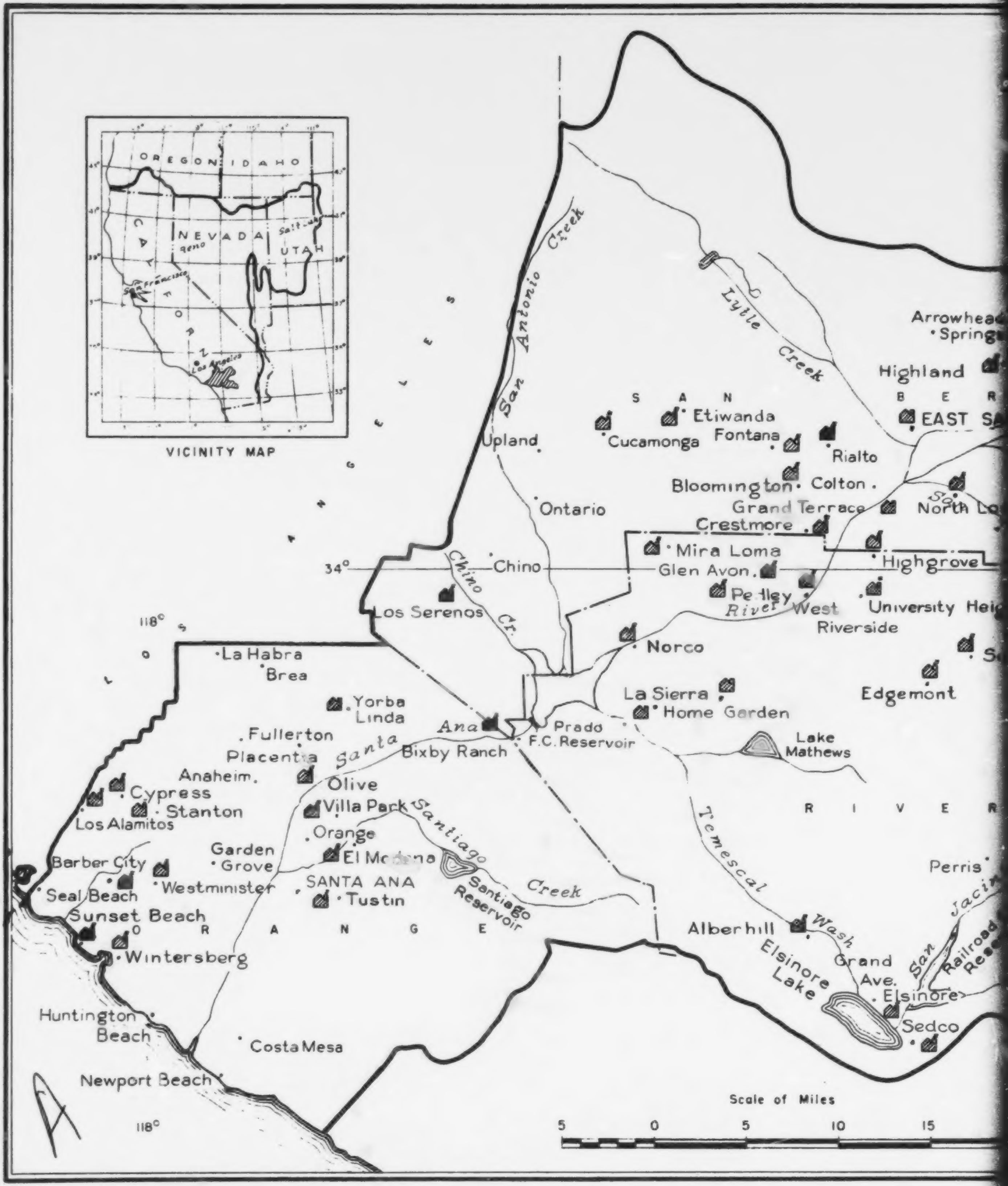
DATE **MARCH 1, 1951** PLATE NO. **6**


SAN BERNARDINO COUNTY
LOS ANGELES COUNTY
LA HABRA
FULLERTON
PLACENTIA
BUENA PARK
ANAHEIM
②
③
U.S NAVAL RESERVE AIR BASE
ORANGE
GARDEN GROVE
U.S NAVY NET & AMMUNITION DEPOT
SEAL BEACH
SUNSET BEACH
①
SANTA ANA
TUSTIN
U.S NAVY LIGHTER-THAN AIR BASE
⑦
U.S. MARINE CORP AIR BASE
⑪
⑥
HUNTINGTON BEACH
⑤
NEWPORT BEACH
⑧
LAGUNA BEACH
N
S
P A C I F I C O C E A N
LEGEND AND NOTES
⑦ SANITATION DISTRICT NUMBER
SANITATION DISTRICT BOUNDARY LINES
EXISTING TRUNK SEWERS (JOINT OUTFALL SEWER)
SUBBASIN BOUNDARY
SCALE IN FEET
5000 0 5,000 10,000 15,000 20,000

SANTA ANA RIVER BASIN
CALIFORNIA

ORANGE COUNTY
SANITATION DISTRICTS
FROM ORANGE COUNTY SEWERAGE SURVEY

U.S. PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL
DATE MARCH 1, 1951 PLATE NO. 7



OREGON
IDAHO
NEVADA
UTAH
CALIFORNIA
Reno
Salt Lake
San Francisco
Los Angeles
VICINITY MAP
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
San Antonio Creek
Lytle Creek
Arrowhead Springs
Highland
EAST SAN
Etiwanda
Cucamonga
Upland
Fontana
Rialto
Bloomington
Colton
Grand Terrace
North Lo
Crestmore
Ontario
Mira Loma
Highgrove
34°
Chino
Glen Avon
Chino Cr.
Pedley
River
West Riverside
University Heig
Los Serenos
118°
Norco
La Habra
Brea
La Sierra
Home Garden
Edgemont
Yorba Linda
Santa Ana
Prado F.C. Reservoir
Fullerton
Placentia
Bixby Ranch
Lake Mathews
Anaheim
Olive
Cypress
Stanton
Los Alamitos
Villa Park
Santiago Creek
Orange
Temescal Wash
Garden Grove
El Modena
Barber City
Westminister
SANTA ANA
Tustin
Santiago Reservoir
Perris
Seal Beach
Sunset Beach
Alberhill
San Jacinto
Wintersberg
Elsinore Lake
Grand Ave.
Railroad Rese
Elsinore
Huntington Beach
Sedco
Costa Mesa
Newport Beach
118°
Scale of Miles
5
0
5
10
15

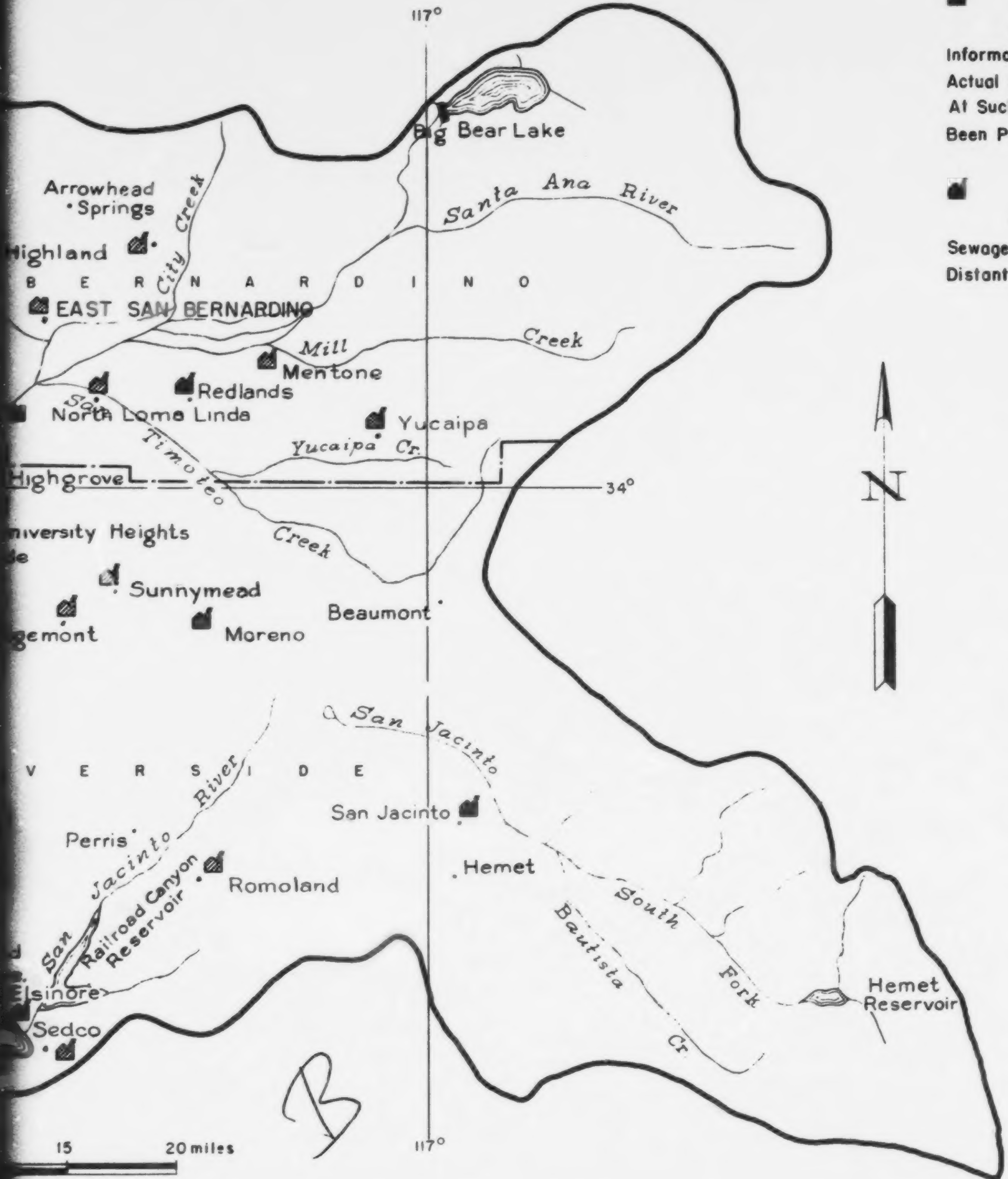
LEGEND

▨

Communities That, On The Basis O
Information, May Need New Or Improved
Actual Nature Of Improvements To Be De
At Such Time As The Problem Becomes C
Been Prescribed By The Regional Board

▨

Communities That Have Neither Pu
Sewage Treatment Works But May Need
Distant Future.


117°
Big Bear Lake
Santa Ana River
Arrowhead Springs
City Creek
Highland
B E R N A R D I N O
EAST SAN BERNARDINO
Mill Creek
Mentone
Redlands
North Loma Linda
Yucaipa
Yucaipa Cr.
San Timoteo Creek
Highgrove
34°
niversity Heights
de
Sunnymead
gemont
Moreno
Beaumont
N
San Jacinto
V E R S I D E
San Jacinto River
San Jacinto
Perris
Romoland
Railroad Canyon Reservoir
Hemet
South Fork
Bautista Cr.
Hemet Reservoir
d
Elsinore
Sedco
B
15
20 miles
117°

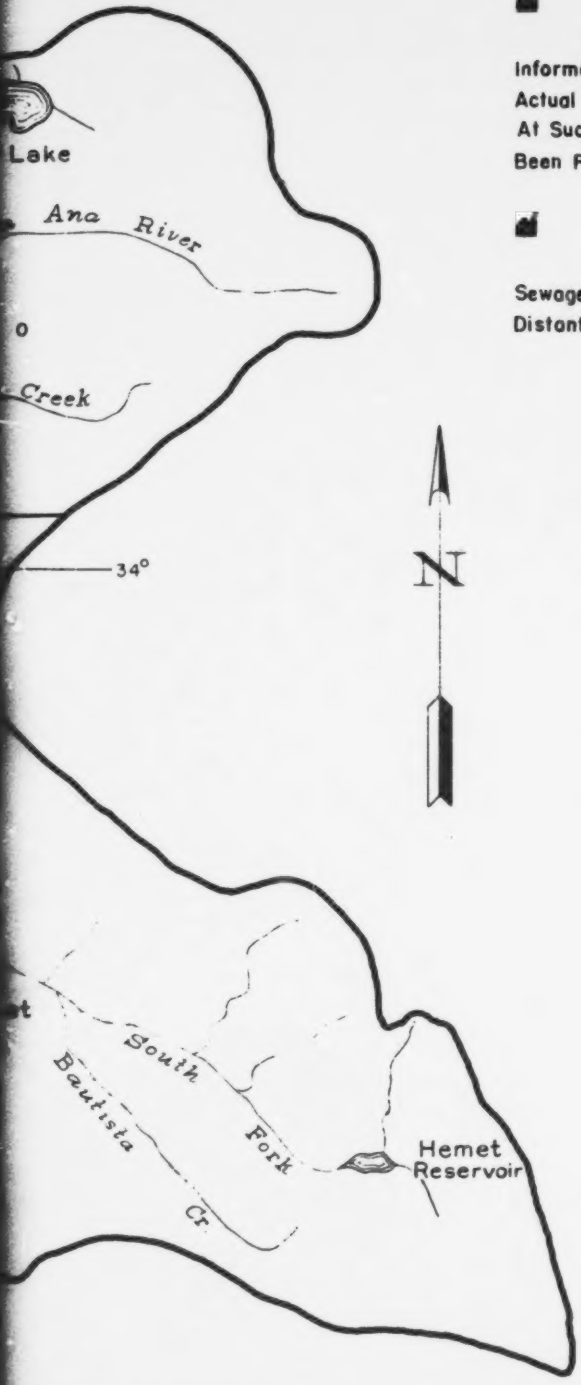
SANTA
C

POSSIBLE PR
SEWERA

U.S. PUBL
DIVISION OF WA

DATE MARCH 1, 1951

1



LEGEND

■

Communities That, On The Basis Of Presently Available Information, May Need New Or Improved Waste Treatment Facilities; The Actual Nature Of Improvements To Be Determined By The Communities At Such Time As The Problem Becomes Critical And Requirements Have Been Prescribed By The Regional Board.

■

Communities That Have Neither Public Sewer Systems Nor Sewage Treatment Works But May Need Such Facilities In The Not Too Distant Future.

C

SANTA ANA RIVER BASIN
CALIFORNIA
POSSIBLE PRESENT OR FUTURE
SEWERAGE PROJECTS
U.S. PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

DATE MARCH 1, 1951 PLATE NO. [illegible]